EMGT 835 FIELD PROJECT:
Skills Profile and Training Delivery Review for Engineering Production Support—Cessna Aircraft

By

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EXECUTIVE SUMMARY

The purpose of this field project was to lay the foundation for technical skills improvement for Cessna Engineering Production Support (EPS) through a training objective statement and defining the skills profile for the Components Manufacturing Facility EPS Engineer. The training objective statement was developed using a situational analysis of the EPS operations with input from management, customers, and other stakeholders. The current state of business was reviewed as well as the envisioned future state where EPS Engineers utilize Stress and Fatigue specialists with significantly less frequency. The resultant statement reflects emphasis on engineers obtaining required yearly training in subjects which the engineer and immediate supervisor feel best benefits the growth and development of the engineer while fully serving the needs of the business.

Additionally, a strategic skills analysis (SSA) was performed on the EPS Engineer's task of developing answers to nonconformances to obtain a prioritized future knowledge, skills, and abilities (KSAs) skills profile. The process utilized the situational analysis above plus a task analysis. Seventeen engineers participated in a survey to rate perceived importance of the identified KSAs. Survey results were used to define a priority ranking for the KSAs in the skill profile.

The training objective statement will help drive job-relevant instruction for EPS. The skills profile will provide Cessna return on investment through targeted hiring in EPS and reduced response time on future nonconformances.

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1.0 INTRODUCTION

The mission of Engineering Production Support (EPS) is: “to contribute to organizational success (Cessna objectives “Superior Product Safety & Quality” and “Financial Performance”) by delivery of cost-effective, engineered solutions to nonconforming details and assemblies for all Cessna products. The emphasis is first on the safety of our external customers, second on assembly integrity, and lastly, response time and economy.”

To contribute more to the organizational success of Cessna, management has an evolution in mind to better serve EPS customers and ensure more appropriate repairs are developed within EPS. The future vision of EPS is to provide complete engineering support for all Cessna and many supplier/partner manufacturing areas. This means the individual engineers will review nonconformances, analyze solutions, affect corrective actions, and provide technical feedback to design engineers on all repairs without utilizing the specialist departments. This is done now to an extent. The vision is a move toward complete autonomous operations – no need to consult specialist groups for technical help.

The EMGT course work at the University of Kansas uncovered several opportunities for further exploration within Engineering Production Support. The need for an improved training mechanism in the Engineering Production Support (EPS) group became exceedingly prevalent when working through the Malcolm Baldrige National Quality Award Assessment (self-assessment) assignment for EMGT 808, Quality Management. Since upper management is suggesting an evolution within EPS and training is an issue for EPS Supervisors, developing an EPS skills profile was chosen as a field project. This effort will help direct the development of EPS engineers in the future and set the stage for beginning the trek to a more independent operation.

1.1 BACKGROUND

Aircraft manufacturers like Cessna are unique in the manufacturing sector. That uniqueness is defined by a lawful requirement to operate an organization that has the sole purpose of figuring out what to do with nonconforming parts. Appendix A contains the complete FAR 21.125 regulation specifying operation of a Material Review Board (MRB). At Cessna, Engineering Production Support is the engineering department whose members belong to the MRB. The department is “…a committee of individuals of various specialties assigned the task of determining what to do with incorrectly made parts, otherwise called nonconforming parts" (Noe, 1993, p.1). Since Cessna Aircraft operates in several locations, an EPS representative must be present at each location.

To meet this need EPS has multiple groups of engineers organized as three sections with ten different locations. The sections are Components Manufacturing Facility (CMF), Assembly, and Flight. The locations by section are listed in Exhibit 1.1.

Since technical ability varies across the EPS organization different solutions to similar nonconformances will occur. As assignments change the engineer takes his or her expertise to the next assignment leaving the shop with an engineer who may have significantly different biases about what it is important for the parts or assemblies being built. These biases are certainly dependent upon the engineer's education, level of experience, familiarity with the product in question, and how/when/by that he or she was trained. This fact gives Operations Managers discomfort as solutions vary by location and assignment. The Operations Manager expects a solution similar to one received the last time a similar nonconformance occurred.

EXHIBIT 1.1. LIST OF EPS LOCATIONS – CESSNA FACILITIES ONLY

Components Manufacturing Facility	*Assembly*	*Flight*
Columbus (Columbus, GA)	Experimental (Wichita)	W3 (Wichita)
McCauley (Columbus, GA)	Bondshop (Wichita)	W16 (Wichita)
Pawnee (Wichita)	W7 (Wichita)	
	Sovereign (Wichita)	
	Singles (Independence, KS)	

1.2 SITUATIONAL ANALYSIS

Prior to mid-2002 no concerted effort had been applied to training the new EPS engineer. The methodology used was that typical of many businesses with technical professionals-the newly hired trainee followed an assigned individual or group until the skills required for the job were picked up. This haphazard way of training left many individual engineers frustrated, unprepared for challenging nonconformances, and likely contributes to employee turn-over.

In 2002 the *Engineering Production Support Handbook* (Cessna, 2002a) was brought into existence due to economic growth assumptions. The *EPS Handbook* is a guide for the new hire explaining the work done, the basic procedure of how it is to be performed, what tools are used, and serves as a basic reference guide. What was thought to be the most important section of the

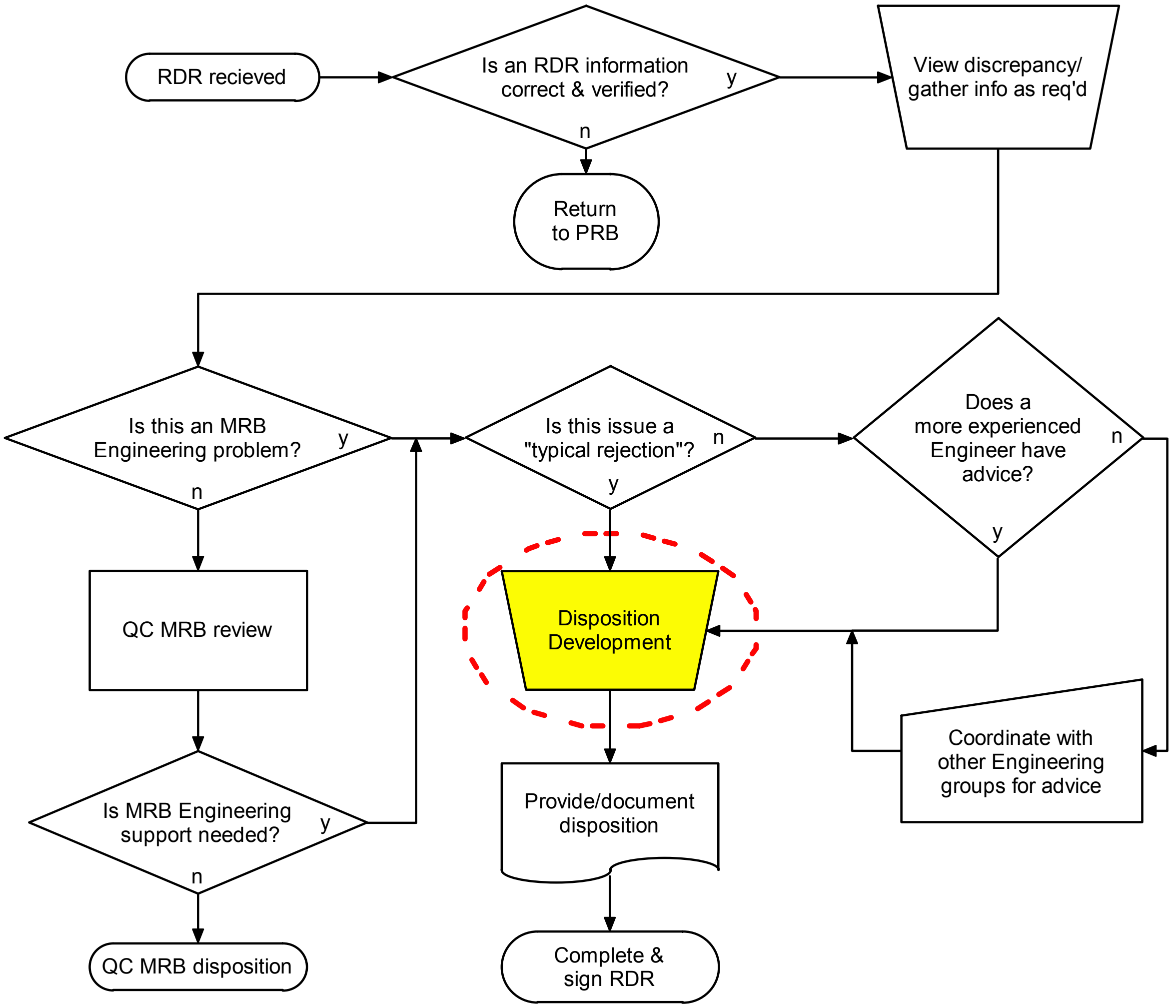
EPS Handbook was the generic training plan which the supervisor/trainer/coach was to modify to meet the needs of the new hire including consideration for the learning style that suits the new hire. The handbook also contains a "roadmap" which lists subjects that the supervisor or coach should be teaching the new hire. This list does not get into the technical knowledge used to develop dispositions, but does cover a variety of topics of general interest. Appendix B contains a reprint of the Training Plan section of the *EPS Handbook* for reference.

Use of this guide has been sporadic at best with mixed results from new hires and supervisors alike. A shortcoming with the handbook is the lack of technical training suggested and made available by Cessna. Use of this handbook has not been adequate in building skills in the new engineer nor will it meet the needs of EPS development towards autonomous operations.

1.2.1 Skills Profile

There are several mechanisms available to Cessna's Engineering Management to prepare EPS for growth in responsibility. A common thread among the alternative training and performance improvement methods could be described as a skills profile. The skill profile output will help institute developmental goals and prioritize skills training (Rothwell, 1998). Because the bulk of EPS work revolves around providing the manufacturing facility with answers to nonconformances (dispositions), this project will focus on solely on that task. Exhibit 1.2 illustrates the process flow of nonconformances through EPS. The highlighted action box, Disposition Development, is the focus of this project.

EXHIBIT 1.2. EPS REJECTION ANSWER FLOWCHART (PROCESS FLOW)



1.2.2 Training Delivery Inventory

Once performance goals have been identified and training topics prioritized, the delivery mechanism must be chosen. The need for a tailored training delivery mechanism is evident due to the widespread EPS locations. The ten locations listed in Exhibit 1.1 have a variety of facilities and experts on-site who have the capability to design and deliver training. The available training facilities range from a single meeting room to a fully equipped video conferencing center. On-site experts range from none to several depending on subject. Eight of the ten facilities are in the same city, however, are geographically separately by up to 15 miles.

Current training delivery methods used at Cessna in order of volume are computer based training (CBT) (including web-based delivery-WBT), live instructor (ILT), videotape, and occasional University short courses brought in-house. Technical training available at Cessna does not appear to be effective. In general, the courses are simply technical topic familiarization sessions. Knowledge transfer on complex topics is unlikely through one-to-four hour sessions with no pre- and post-knowledge assessment (Eurich, 1990).

1.3 Project Scope and Objectives

EPS stakeholders include production supervisors, inspection supervisors, quality representatives at Cessna and suppliers, and project engineers. Customers are production foreman and mechanics/line operators. Skills improvement is a requirement to achieve the goal of more autonomous operations. To facilitate the start of this skills improvement effort, a strategic skills analysis (SSA) will review the current skills within EPS in regard to disposition development and compare to the future knowledge, skills, and abilities (KSAs) desired. The major objectives of this field project are

- determine training objective statement for Cessna EPS
- develop skills profile plan for CMF EPS, including
  - prioritized Knowledge, Skills, Abilities (KSAs) critical for the future
  - select training delivery mechanisms appropriate for all EPS locations (top ten KSAs)
  - establish an estimated budget required for training delivery

The intent of this plan is to lay a foundation for technical skills improvement for this department.

2.0 LITERATURE REVIEW

Cessna defines Engineering-On-The-Job-Training (EOJT) as "…a structured, Coach-led training methodology, based on a Roadmap of skill proficiencies and process understanding, designed to reduce the time to proficiency of new team members" (Cessna, 2002b, p. iv).

The engineering environment is much like many other intellectual career paths where knowledge power is key in generating solutions and creating new products. Those key creative intellectual events, the reason the learned engineer is employed, are flanked by much work that is mechanical in nature and adds little value to the end product. The mechanical work is not in question here; the knowledge power is. Knowledge transfer from worker to worker is important for consistency in product and completeness of solution while meeting the customer needs. A large body of knowledge exists on the methods available for training/retraining physical skills and developing a training program, including skill assessments (Sheets, 1994). However, based upon the author's literature search for knowledge assessment and transfer, not many resources exist for training technical or intellectual skills in a business environment.

2.1 Historical Background

One hundred years ago, the typical worker learned the new skills necessary for doing a job the "right way" simply by observing their mentor in action and imitating the motions. Later, that worker would train the next person when a need arose. After years of picking up skills from previous workers, the job function may have changed significantly or evolved into a different job completely. The change is likely due to biases of the individuals performing the tasks. This method of skill transfer is what Deming calls "worker training worker" (Aguayo, 1990). This can result in product variation and inconsistency based on whom did the work.

In the early 1900s, Fredrick Taylor performed his now famous research on time and motion of workers. The culmination of his work in *Scientific Management* is considered by many to be the masterpiece on which today's art of industrial engineering is based. The commonly accepted result of his work is that any task (skill or ability included) can be broken down into smaller and smaller tasks until anyone can be trained to perform (Aguayo, 1990). The benefit is that highly skilled, specialized workers are not needed for tasks that have been successfully analyzed. Machinery and simple tasks replace complex thought processes and subjective criteria.

Both of the above training mechanisms are still used by many businesses today. Cessna EPS is an example. Mundane data entry tasks have been broken down into mechanical steps with explanations of where/when to populate data fields. While the more complex skills involved in developing dispositions have been handed down by worker watching worker, worker telling worker.

2.2 Current Perspectives

Not many things are certain in the business world of today. One thing that is certain is change. The business powers of today must be adept at coping with change and coping with a diverse workforce as markets evolve (Eurich, 1990). The formal education industry has been coping with change as the new student of higher learning has evolved from "young unattached adults" (Dixon 1996) into young adults with responsibilities, older workers, single parents, and generic lifelong learners. Changes to meet the needs of new learners include remote course delivery, virtual colleges, class at all hours of the day and night, etc. (Dixon, 1996). Like colleges, businesses of today must also change the way they train workers, as a strategy to keep up with the markets (Thompson and Strickland, 2003). This is key to developing core competencies and maintaining market-edge over the competition. The customers' demand for consistent products and high-quality are also drivers of worker skills improvement. The days of evolving product variation and accepting output variation are over according to Ross Dawson in *Developing Knowledge-based Client Relationships* (2000).

An internet and online database search was also conducted on the subjects of "engineer training," "professional engineering development," and various forms of "on the job training." YAHOO!, Google.com, and AskJeeves.com were utilized for the internet search. Results of usable articles are listed as cited articles provided in the References and Bibliography. Multiple searches were conducted between September 2004 and March 2005.

The online databases searched were COMPENDEX, Dissertation Abstracts, Business & Company Resource Center, and OmniFile. Many apparently relevant articles were listed (concerning professional engineering development) but were not found to be research sources. A secondary search through the Wichita Public Library database contracts was also unsuccessful at producing usable resources. A previous EMGT Field Project authored by Brian Sheets, *An Analysis of Training Needs for New Mechanical Engineers and Review of Training Program in Black & Veatch's Power Division* (1994), was found with help from KU Libraries staff. This write-up relates to an evaluation of the former training program in place at Black & Veatch and suggests changes to fulfill the job needs as a mechanical systems engineer.

2.3 COMMENTS

An unexpected book was found which details much of the work the Production Support Engineer actually does. That book is *MRB Engineering Handbook* by Robert Noe (1993). Mr. Noe's discussion of the procedures and operations the EPS Engineer can/must do as part of his daily work is exceptionally accurate. However, no specific skills are identified or training recommended on which to base decisions made within MRB Engineering procedures and tasks.

Many resources were found with regard to designing a skills training program. Although presented in several different styles and number of steps, the common path among the multiple sources is: 1) assess need for training, 2) develop learning material, 3) implement course materials, 4) implement follow-up mechanism. Actually developing the course material is out of the scope of this field project. This project will focus on assessing the need for training in partial completion of step 1) above. The path chosen for use in this skills assessment is that from the article "Strategic Skills Analysis for Selection and Development" by Tim and Suzanne Summers (1997). Imperative to strategic skills analysis (SSA) is not only considering the current needs of the customer but also the future needs of the business and customer. This information is potentially of great significance in recruitment, selection of future employees, and training development (Summers & Summers, 1997).

A key to using SSA is identifying the knowledge, skills, and abilities (KSA) of employees, particularly power-employees. A full SSA review of all positions in a business can be the frontline in preparing a workforce for the future (Summers & Summers, 1997). SSA is NOT a recipe for employee development, but is a method of preparation to meet or exceed competitive pressures and excel as a 21st century business. Summers and Summers do not list the steps of performing an SSA directly; however, the generic steps are as follows:

- Consider needs of customers and business plan
- Plan strategic analysis
- Select jobs for strategic analysis
- Perform job analysis
- Create task-oriented KSA database
- Perform strategic analysis
- Update KSA database to meet business strategy

3.0 PROCEDURE AND METHODS

As mentioned in Section 2.3 many training development resources detail the condensed path as: 1) assess need for training, 2) develop learning material, 3) implement course materials, 4) implement follow-up mechanism. This project will partially complete the first step. Assessing the need for training implies that a performance problem exists and that a performance problem can be remedied with training and practice. Assessing the need for training also takes into account the environmental, organizational, and motivational issues that affect employee performance (Rothwell & Kazanas, 1998).

At this time the author assumes that a performance problem does NOT exist and assessment is out of scope for this project. The project emphasis, rather, comes from management discussions of future EPS functionality that dictate changes must be made. Evolution of the process machine must happen. Skills improvement is an expected requirement to achieve the goal of more autonomous operations within the EPS groups. Some hurdles must first be traversed before the skills improvement can commence. The first hurdle, starting the effort, will be described in this section. The details behind the procedures and methods used in this project will be presented. Items discussed will be the development of the training objective statement and skills profile.

3.1 TRAINING OBJECTIVE

The training objective statement is key in beginning the skill improvement effort. Without providing guidance in support of the vision, training for EPS members may be disjointed and inefficient. Adult learners often need or demand consistent reinforcement of why they are training and/or changing the way they do business (Knowles, 1996). A different way to describe it is the training must have a valid purpose in the eyes of the trainee. Without their buy-in even precisely laid ground work and the best training possible, skills improvement and change will not happen (Knowles, 1996).

The building blocks for the training objective statement will depend upon the current perceived state of business in EPS as well as the intended future. A situational analysis will be conducted with input from the current EPS Supervisors, the Department Manager, and a review by the ASIP Director, and consultations with the key stakeholders as defined from that situational analysis. The situational analysis for the current state will be summarized in the 7S format.

3.1.1 Situational Analysis-Current State

Why perform a situational analysis? In terms of a department, a situational analysis is valuable as it provides an overview of the operations. It can define how well the current operating strategies are working, in a qualitative sense (and quantitative sense, if possible) (Thompson & Strickland, 2003). A simplified concept here is that of defining resources and how they are used in pursuit of the value-added activities – department functionality in this case. A key output from the situational analysis can be core competencies. A core competency is one that gives the department a distinctive advantage in performance. These core competencies are strategically more important than others as they add strength to the company's market position or support the corporate/organization objectives in efficient fashion. Enabler might be the proper term to describe strategically important competencies. As an enabler the competency, and hence the department, are effective in completing the assigned tasks and successful at carrying out the department mission. Additionally, the situational analysis itself is an enabler in refining and/or redefining the goals of a department. In this field project, the situational analysis is a major component in the strategic direction for the EPS groups.

Using techniques learned in the Engineering Management program at the University of Kansas, specifically EMGT 821, a situational analysis will be performed. Tools used in this situational analysis are listed in order to be used and briefly described below. The purpose of choosing these tools is to develop a common understanding of the business in EPS.

1. Value Stream Map – A value stream is all the steps (value added and non-value added) of a process. It can include the entire chain from raw material to end product ready for the customer or it may only contain the activities of a department. It provides management with an understanding why a company does or does not possess a competitive advantage and identifies potential opportunities that may improve its competitive positioning (Thompson & Strickland, 2003).
2. SWOT – Strengths, Weaknesses, Opportunities, and Threats: These four lists are used to evaluate how well the strategy is matched to the company's strengths and opportunities and how much effort should be applied to guarding weakness and defending threats (Keller, 2003).
3. KSF – Key Success Factors are particular elements of the business, core competencies, competitive capabilities that give it competitive success over its rivals.
4. Objective/Priority List – Listing current or future department objectives and comparing that list to the current measures or demonstrated priorities can illustrate operational effectiveness.

In terms of situational analysis, this is a reference for management to determine if operational direction matches strategic guidance.

5. MBNQAA – The Malcolm Baldrige National Quality Award Assessment is an excellent tool to facilitate a critical look at leadership in an organization. Seven areas are judged for outstanding performance: leadership, strategic planning, customer and market focus, information and analysis, human resource focus, process management, and business results. The major purpose of performing the Malcolm Baldrige National Quality Award self-assessment is to understand what areas of business need improvement and what areas are performing at exceptional levels. This is used to generate a list of gaps.
6. Stakeholder List – A generic definition of stakeholders are ". . .people who will be affected by the project or can influence it but who are not directly involved with doing the project work. Examples are Managers affected by the project, Process Owners, People who work with the process under study, Internal departments that support the process, customers, suppliers, and financial department" (Olson, 2003).
7. 15 Word Document – This is a short statement that sums up a concept. It is a single statement that reflects the consensus of the group. The main purpose is to describe a collective understanding (TSS, 2003).
8. 7S – The 7S model is a strategic planning tool. Exhibit 3.1 shows the typical format of the 7S model. The content of the S's must be non-conflicting and work in harmony to form a coherent picture of the organization.

EXHIBIT 3.1. GENERIC 7S MODEL

Mission (Shared Values)	• X
Strategy	• X
Skills	• X
Staff	• X
Organization Structure	• X
Systems	• X
Culture (Style)	• X

3.1.2 Defining EPS Future State

The output from the situational analysis tools completed in pursuit of this project in conjunction with the Cessna GDP objectives will be used to form the future state of EPS. The Visioning tool from *Textron Tap Tool v1.0* (TSS, 2003) will be used to summarize a series of informational meetings between EPS Supervisors, the EPS Manager, and ASIP Director. This future state description will be a reference to a potential evolution within EPS as desired by management. Direct input from the EPS Supervisors, EPS Manager, and ASIP Manager will be used to craft a description of the future EPS department. Below is a brief description of the visioning tool.

- Visioning – The objective is to translate a future state idea into a concrete description of what people will be doing once success has been realized. The main point centers on imagining a point in the future when the project has been successful, the objectives have been met, and people have internalized the change effectively. Visualizing the performance changes in terms of financials, culture, employee satisfaction, etc. is the expected output from using this tool (TSS, 2003).

The three major Cessna Integrated Supply Chain objectives (EPS is an Engineering organization that directly supports Integrated Supply Chain) that this project will promote are 1) "Achieve Net Cost Reduction target" (through employee development), 2) "Increase Lean MRB dispositions from 75% to 95%" (within 72 hours) 3) "Execute Lean Enterprise Plan on schedule." The intent of these three objectives is to do "it" more economically through more talented employees with fewer resources. This translates into a finished product in a shorter amount of time. Since time is money, cost is accruing while waiting to complete the product. The product is waiting to be completed while EPS is working to answer nonconformances.

3.2 Skills Profile Development

The path chosen for this skills profile is that from the article "Strategic Skills Analysis for Selection and Development" by Tim and Suzanne Summers (1997). SSA considers the current needs of the customer AND the future needs of the business and customer. It is important to note that this effort is not a skills assessment in the traditional sense. An assessment implies that a test or related proficiency instrument is used to evaluate an employee's skill or ability level (NCREL, 1999). The point of this section is to develop a list of KSAs that will be used in future EPS work.

3.2.1 KSAs Critical to Future EPS

Summers and Summers do not list the steps of performing an SSA directly, however, the generic steps are listed below in Exhibit 3.2. The first two steps will be completed by the three CMF EPS leads during the situational analysis explained in Section 3.1. Step three is identifying the jobs for strategic analysis. Since this project is centered on the primary function of the EPS Engineer (developing dispositions), EPS Engineer is the job selected for this SSA.

Exhibit 3.2. Generic Steps to Strategic Skills Analysis

1. Consider needs of customers and business plan
2. Plan strategic analysis
3. Select jobs for strategic analysis
4. Perform job analysis
5. Create task-oriented KSA database
6. Perform strategic analysis
7. Update KSA database to meet business strategy

Steps four and five, task analysis and KSA database, are the bulk of the effort for this project and are covered in the next section. Step six, perform strategic analysis, is performed as part of defining the future state of EPS as per section 3.1.2. Lastly, updating the KSA database to meet business strategy will be included in the next sections.

3.2.1.1 Task Analysis Procedure

The expected result of performing a task analysis is a database of KSAs key in performing the task at hand. This task analysis will use traditional tools; templates from Don Clark's *Analysis Template Book* (2001) will be utilized after modification. Where traditional job task analysis uses job, duty, task, and element analysis to arrive at the skills/knowledge needed to perform the work, this profile will use EPS Engineer (job), answer nonconformance (duty), develop disposition (task), major categories of nonconformance (element), and process components analysis to arrive at the KSAs used. This analysis begins by identifying major categories of nonconformance in review sessions with current engineers of various experience levels at the three different locations.

A list of typical nonconformance types will be generated during meetings between leads and group members. Next, determining knowledge, skills, and abilities associated with each identified nonconformance category will be done via brainstorming sessions in groups of four or more EPS Engineers and one lead. The three Components Manufacturing Facility EPS groups participating in this job analysis are shown in Exhibits 3.3 through 3.5.

EXHIBIT 3.3. COLUMBUS CMF ENGINEERING PRODUCTION SUPPORT GROUP

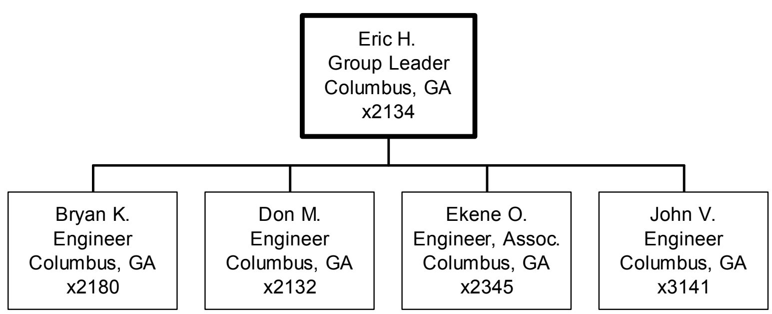


EXHIBIT 3.4. MCCAULEY CMF ENGINEERING PRODUCTION SUPPORT GROUP

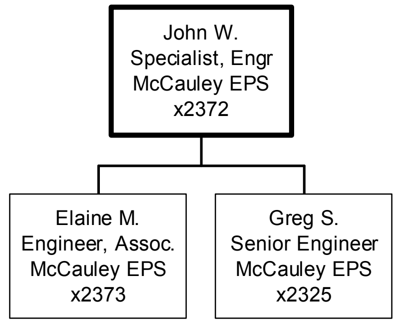
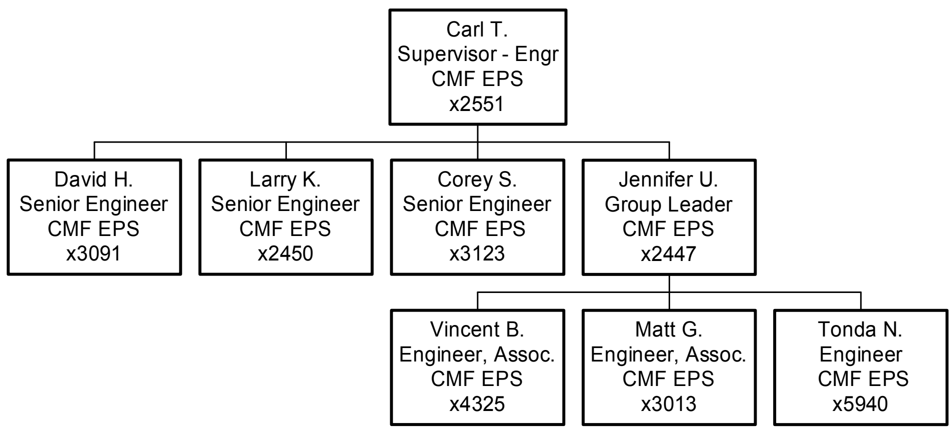


EXHIBIT 3.5. WICHITA CMF ENGINEERING PRODUCTION SUPPORT GROUP



Definitions of knowledge, skills, and abilities must be used to keep classifications consistent. The following three paragraphs explain the meaning of each term used in this analysis. The definitions are paraphrased from Rothwell & Kazanas's *Mastering the Instructional Design Process* (1998).

Knowledge – a body of factual information which is applied directly to the performance of a task. Examples are "knowledge of engine components and their functions, knowledge of engine disassembly/assembly procedures, knowledge of pneumatic control systems, knowledge of engine timing diagrams, knowledge of engine gas compression cycles."

Skill – a present, observable competence to perform a psychomotor act. Examples are "skill in overhead crane operation, skill in use of Engine Maintenance Analyzer, skill in use of computers."

Ability – is the power to perform an activity that is distinguishable from a skill by the absence of a learned psychomotor component. Examples are "ability to locate information in manuals, ability to use precision measurement tools, ability to analyze and solve complex problems, ability to detect slight differences in engine performance."

The supervisor must remember to facilitate the sessions to keep the KSA discussion focused on disposition development. Many activities the EPS engineers do will not be covered in this job analysis. Examples of items not covered are email etiquette, voicemail usage, PC skills, network navigation, manufacturing/machine facilities layout, corrective action application, etc. These activities are taken for granted and assumed to already have written guidelines or will be the subject of another project.

3.2.1.2 Prioritized KSAs Procedure

Prioritizing KSAs will be done via a survey to determine how critical the EPS Engineers feel the knowledge, skill, or ability is to successful development of disposition and how often they perceive the K, S, or A is used. The survey is a modified form taken from Don Clark's *Analysis Template Book* (2001). A sample survey form is included in Appendix C for reference.

The intent of the survey is to provide meaningful perceptions of which KSAs are most needed for successful completion of EPS dispositions. The survey was also designed to be relatively easy and quick to complete. The data from completed surveys will be manipulated to show engineer agreed upon KSAs required for answering nonconformances. The summation of the survey is a KSA database or skill profile. To establish which KSAs are most needed for developing dispositions, raters are asked to identify the level of criticality the KSA plays in disposition development and frequency of use.

Each KSA is to be rated on the survey using a 1 to 5 scale for both the perceived criticality and perceived frequency of use ratings. A value of one (1) means little/no importance and almost never used. A value of five (5) means most important and used on an hourly basis. The ratings from one to five mean subjectively higher perception of criticality to disposition and higher frequency of usage. These ratings will be input into a spreadsheet directly by raters or by the author. The raw data will be compiled in Appendix D.

Criticality multiplied by frequency of use will be used to determine KSA importance to successful disposition development. KSAs with higher values are more important to disposition development. This follows from the fact that most of the identified KSAs are used in several of types of nonconformances. KSAs used in more types of nonconformances are used more often and are, therefore, strategically more important than those used sparingly. Contrarily, KSAs used sparingly may be of the utmost importance for dispositioning some types of nonconformances and are therefore more critical. The KSAs will be ranked by the average value of criticality times frequency for each rater and presented as the priority ranked KSAs in the Results section.

Raters will also be asked to input how many training hours they feel it takes to become proficient in the listed KSAs based upon their experiences. The purpose is to collect the range of training hours spent on any one KSA. Also, at the bottom of the survey raters will be allowed to write-in any additional KSAs with an explanation. This technique can be beneficial in minimizing the possibility that a key KSA may have been missed in the original brainstorming sessions.

3.2.1.3 Updated Prioritized KSAs Procedure

Lastly, the rating process will be repeated after identification of key KSAs associated with the identified future state of EPS work. Since the future of EPS involves significantly reduced stress and fatigue "consultations," it may be inferred that the future skills profile of EPS Engineers will include those KSAs used by the stress and fatigue engineers who do the majority of the nonconformance consultations.

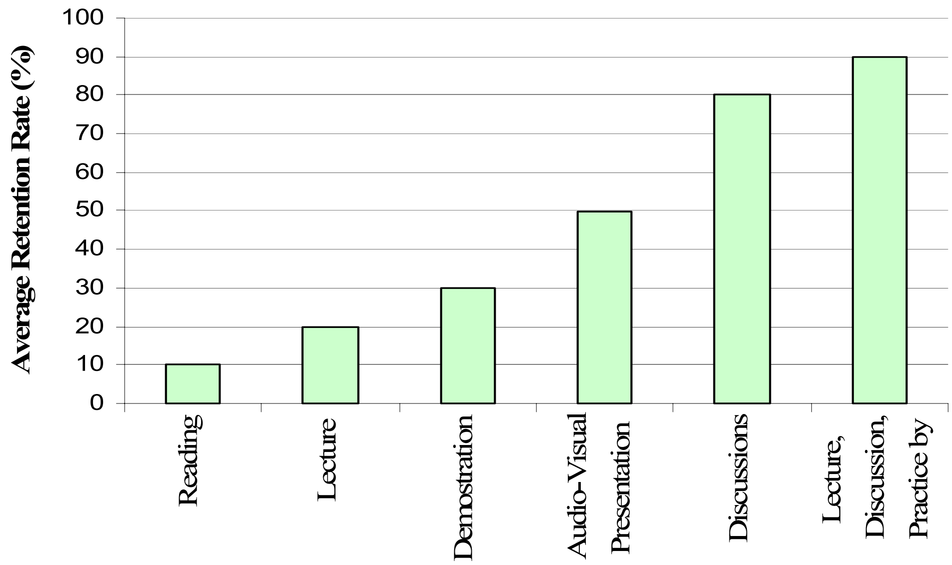
Five current stress engineers and three fatigue engineers will have KSA identification sessions with the author using the procedures as presented in Section 3.2.1.1, Task Analysis Procedure. Next, the future state KSAs will be prioritized using the same procedure as presented in Section 3.2.1.2, Prioritized KSAs Procedure. The criticality and frequency of use ratings will be done relative to dispositions that require analysis to support. The rating will be performed by the four Components Manufacturing Facility EPS Engineers who are former stress or fatigue engineers. The same survey as above will be used. The prioritized future state KSAs will be added to the current state KSAs list and ranked with the current state KSAs to form the future state skills profile.

3.2.2 Review of Training Delivery Mechanisms

Regardless of the technical subject being addressed, knowledge delivered, skill attempting to be taught, or ability presented in training, the information must be delivered in a manner consistent with the learners' constraints. The media selected will be affected by time limitations, equipment available, teacher skills, costs, and management preference (Kruse and Keil, 2000). The purpose of this section is to determine the possible training delivery methods to be used for delivery of future training in topics from the prioritized future skills profile.

The available literature and the Cessna Learning & Development Department indicate that a number of training delivery mechanisms exists. Estimated costs vary widely and are a likely limiting factor in choosing a delivery media. Learner preference is also a limiting factor. Older learners tend to be partial to traditional classroom based instruction as some technology-based systems might be out of their comfort zone (Munger, 1997). The learning process should be a blend of expositive and experiential techniques to ensure knowledge transfer has occurred. Recalling from an EMGT 809 Presentation by the author, learner's retention is a function of their participation in the learning. Exhibit 3.6 illustrates learner retention.

EXHIBIT 3.6. LEARNER RETENTION RATES BASED UPON LEARNING PARTICIPATION



(data taken from Sharon Bowman's *How to Give IT so They Get IT* (1998))

Delivery methods can be defined to be either of two types, synchronous or asynchronous. Synchronous is considered to be real-time learning events where instructor and participants work together to impart knowledge, such as classroom training. Asynchronous delivery is where the participants are accomplishing a learning event and cannot interact with the instructor or others in real-time, such as computer-based delivery. Most e-learning or technology-based instruction uses a significant amount of asynchronous delivery and well-designed courses can have significant advantages (Kruse & Keil, 2000). In addition, Kruse and Keil (2000) also say that technology-based instruction (asynchronous) is most effective for delivering information used in lower levels of cognitive learning because this knowledge can be imparted using language, text, numbers and symbols. Teaching people skills through practice, modeling, or working with knowledge residing in the affective domain is more effective through real-time interactions with instructors. The pros and cons of technology-based instruction are shown in Exhibit 3.7. Exhibit 3.8 lists all possible training delivery methods available at Cessna, according to the Learning and Development Department, along with associated costs and advantages. Exhibit 3.9 is an application table for type of training delivery based upon various factors (reprinted from *Blended Learning-Maximizing the Impact of an Integrated Solution* by Rick Valdez (2001)). This table will be used as a decision tool for choosing the type of delivery method used.

EXHIBIT 3.7. PROS AND CONS OF TECHNOLOGY-BASED INSTRUCTION

Pros	***Cons***
• potentially reduced overall cost	• extreme upfront costs
• reduced learning time	• significant technology investment
• knowledge retention from expert instruction is high	• significantly reduced participant interaction
• consistency in instruction delivered	• requires IT management
• automated completion of documents	• only for stable content
• on-demand availability	• team required to design and build

(Kruse and Keil, 2000)

EXHIBIT 3.8. TRAINING DELIVERY METHODS POSSIBLE AT CESSNA AIRCRAFT

<table>
<tr><th rowspan="2">Training Delivery Method</th><th colspan="2">Description</th></tr>
<tr><th>Benefits</th><th>Costs</th></tr>
<tr><td rowspan="2">Computer-based Training (CBT)</td><td colspan="2">An interactive training effort between a person and computer. Normally the trainee is presented with information, then immediately tested on learning (asynchronous). The program provides certification that the course was completed. Best used when further training is dependent on current employee proficiency. Can be multimedia CD, DVD, for network based. The accepted benchmark for CBT course development is 200 hours per hour of quality finished course.</td></tr>
<tr><td>• Quickly generated
• Stable content</td><td>$5000 / finished hour</td></tr>
<tr><td rowspan="2">Instructional Video</td><td colspan="2">The basic form of asynchronous training. Can used in conjunction with classroom training and supplemented with printed or written materials. Often used in CBT. This is an excellent way to illustrate simple procedures. Also, useful for trainees in different locations. Amateurish presentation leads to disconnected participants. The standard is approximately 50 hours effort for each finished hour of training.</td></tr>
<tr><td>• Cheap production for stable material</td><td>$1000 / finished minute</td></tr>
<tr><td>Instructor-Lead Training (ILT) Virtual
-or-
Interactive Videoconference</td><td colspan="2">A synchronous training method heavily dependent upon technology. Each location uses video monitors and live cameras over a secure broadband/ISDN connection to see and hear activity at each location. Similar Cessna application is WEBEX – a computer/internet based live audio-PPT course delivery method. Course development time is the same as traditional classroom, 40 hours per finished hour. However, the instructor must be familiar with the equipment or have a proficient assistant. Cost for equipment $25,000 minimum.</td></tr>
</table>

	• Real-time • Convenient for multiple locations	$25,000+ and $2000 / finished hour
Instructor-Lead Training (ILT) Classroom	Classroom training is limited to geographically collocated instructors and trainees. Facilities needed are typically a meeting room, large enough for the training group at hand, with technological resources desired by the instructor. Dynamic instructors are needed to keep participant interested and involved in learning. The accepted benchmark for course development is 40 hours per hour of quality finished course (@ $50/hour assumed cost).	
	• Std approach to learning • Familiar method • Low-cost	$2000 / finished hour
On-the-job (OJT)	Another synchronous training method. Typically a senior group member trains a new hire by assigning tasks and developing understanding of topics through usage and practice. Costs are minimal. Often results in inconsistent knowledge across a group or biases transferred without understanding. This is the current method used throughout EPS. This method has, so far, produced mixed results.	
	• Few resources needed	$50 / finished hour
Print-based	Learning resources delivered via manuals, books, program workbooks, or other printed media. This is the most archaic asynchronous delivery method. Best suited to interesting low-level cognitive learning and must be matched to the learner's style. The accepted benchmark is 20 hours development per hour of finished hour of material (@ $50/hour assumed cost).	
	• Few resources needed • Long shelf-life	$1000 / finished hour
Web-based Training (WBT)	A self-contained asynchronous delivery via the internet. Can range from simple media slides to computer intensive multimedia interactivity. Interesting content can be generated resulting in a rich trainee experience. Unless bandwidth is a limiting factor. The design/development will usually require heavy involvement from outside IT expertise in addition to the instructional experts. Site maintenance is also required at $5000/year. Estimated development time is 100 hours per hour of finished training (@ $50/hour assumed cost).	
	• On-demand delivery • Potentially rich experience	$5,000 / year and $5000 / finished hour

(The above possible delivery methods were listed by Cessna's Learning and Development Department. The other information above was compiled from *Technology-based Training*, by Kruse and Keil (2000), "A guide to high-tech training delivery: Part 1," by Paul Munger (1996), and "Training Costs," from the NCRS (2005).)

3.2.3 Estimated Budget for Training Delivery

The budget estimate for delivering the potentially needed future KSA training will be developed using estimated hours of training for each of the top 10 prioritized KSAs from the skills profile. Exhibit 3.8 will be used for course cost by type of delivery and will be used to predict costs per course (estimated hours of training needed X development cost per finished hour). Only course development and delivery costs will be considered. Man-hours costs for attending training, printed materials, employee travel costs, and other costs will not be considered. The delivery media will be selected by the author considering the appropriate factors listed in Exhibit 3.6 and 3.9.

EXHIBIT 3.9. DELIVERY APPLICATION TABLE

Key: ** » Method applicable. * » Feasible usage, but not best practice.

	Synchronous		Asynchronous				
	ILT Classroom	ILT Virtual	WBT	CBT	Print	Audio	Video
Performance Outcome:							
Recall and simple application	*	*	**	**	**	**	**
Complex application, analysis, synthesis, etc.	**	**	*	*			
Content Stability							
Stable content	*	*	**	**	**	**	**
Dynamic content	**	**	*				
Content Structure							
Structured content	*	*	**	**	**	**	**
Unstructured content	**	**					
Audience Size							
Large audience	*	**	**	**	**	**	**
Small audience	**	**					
Audience Proficiency with Technology							
Proficient with technology	*	**	**	**	*	*	*
Not proficient with technology	**				**	**	**
Participant Collocation							
Collocated	**	**	*	*	*	*	*
Not collocated		**	**	**	**	**	**

(reprinted from *Blended Learning-Maximizing the Impact of an Intergrated Solution* by Rick Valdez (2001), p 8)

4.0 RESULTS

The explicit purpose of this section is to present the results of the Procedure and Methods section. Appendix D contains the raw data used in this project.

4.1 Training Objective Results

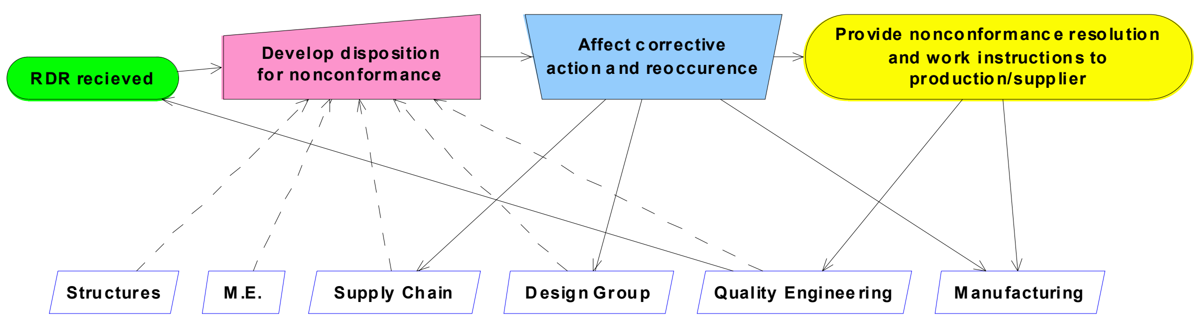
The envisioned future of EPS includes new skills that will require training. This section describes the new training objective statement for EPS.

4.1.1 Situational Analysis-Current State

Input for the following tools was obtained from the three EPS Supervisors, the Department Manager, ASIP Director, and two key Product Managers (key stakeholders). Each tool is preceded by a description paragraph. Following the tools is a summary statement of the current situation.

The simple value stream map illustrated in Exhibit 4.1 is intended to show that EPS interacts with several other Cessna departments. That interaction may be dependence for information and technical skills or may be for delivery of information and work instructions. Below the figure are explanations of each major value stream component.

Exhibit 4.1. EPS Value Stream Map for Disposition Development



RDR Received: The Quality/Inspection department documents the non-conformance on internal forms and sends it electronically to the appropriate individual for review.
Develop disposition for non-conformance: Per 14 CFR Part 21.125, any aircraft manufacturer must have a documented and trusted system to ensure that non-conforming parts are not blindly nor accidentally installed on aircraft (new or used). EPS uses systems and historically developed paths to understand the "why and how" of the non-conformance, pull input from multiple supporting agents (if needed), and prioritize the competing company needs to craft a rapid, cost-effective solution.
Affect corrective action and reoccurrence: After development of a solution, ways to prevent the same rejection from occurring again is explored. If reasons exist which show the issue will

come again, resolutions are put in motion to combat further nonconformances. This is usually managed by supplying manufacturing, design, and supply chain groups with corrective action instructions as necessary.

Provide nonconformance resolution and work instructions to production/supplier: Lastly, work instructions and repair requirements are documented on internal Quality forms and delivered electronically to the appropriate areas to begin part/assembly repair of the non-conformance.

A SWOT analysis can provide a good overview of whether or not a functional department is "healthy." That is, successful in completing its mission and duties. EPS is responsible for answering inspection reported nonconformances. Written repair instructions are delivered for parts and assemblies to make sure the parts meet strength, fatigue, functional, and regulatory requirements. A SWOT also provides guidance when developing a strategy to take advantage of competitive strong points and target strengthening weaknesses. Exhibit 4.2 is a SWOT for EPS.

EXHIBIT 4.2. SWOT TABLE

Strengths	***Weaknesses***
• Excellent communication with production areas • Good understanding of production challenges that affect our ability to produce aircraft • Large pool of experience • Accustomed to high work load and vocal challengers	• Most engineers in dept. lack sophisticated engineering experience • Effectively reduced support due to headcount reductions in support areas
Opportunities	***Threats***
• Expanding capabilities to include more involved design changes • New product lines open new opportunities for group leadership • Outsourcing creating growth • Skills enhancement through Fast Engineering – diversification	• Quality dept. revamp of MRB system to change non-conformance reporting • Outsourcing assembly work • "Embedded" MRB pushing more responsibility onto EPS • Six Sigma efforts focused on eliminating our functions

Key Success Factors (KSF) for the Cessna EPS Department are listed in Exhibit 4.3. These items were determined to be key enablers when spooling up on a new product line. In the past EPS was not directly involved in bringing new products through the experimental stages of development. When the product was introduced into production delays were imposed while engineers learned important characteristics of the new product. The six most recent new models have received EPS support during experimental stages. The newest model had active EPS support during initial engineering design (while still on the drawing board).

EXHIBIT 4.3. KEY SUCCESS FACTORS

• Skills evolving with the new model designs
• Visibility in production schemes as providing value-added services
• Early involvement in new model programs to establish clear connections with design groups and peripheral support groups for future activities

Exhibit 4.4 lists the priorities of the EPS engineer as determined by the EPS Department Manager and ASIP Director. These are the items all EPS personnel are rated upon in order of importance.

EXHIBIT 4.4. EPS 2005 OBJECTIVES

• Safety – Reduce recordable injuries by 10%
• Customer Metrics – Answer at least 70% of rejections within 24 hours and 80% within 72 hours
• Dept Training – Achieve an average of 42 hours of training per employee
• TSS Six Sigma – Train 3 green belt candidates and support Kaizen events with at least 100 hours participation (5 events)
• PMP – Complete staff review of all PMP/MAP candidates on schedule

During the author's experience in the EMGT program at The University of Kansas, the Malcolm Baldrige National Quality Award Assessment was performed upon the EPS department. Gaps as identified in the EMGT808 assignment and reviewed with the Department Manager are listed in Exhibit 4.5. Items starting with the ** may be directly affected through this project.

The stakeholder list is utilized to outline individuals whom have an impact and/or are impacted by the functions of a department or business. The main purpose is to identify key relationships between departments. Exhibit 4.6 lists the stakeholders for EPS.

Lastly, the 15 word document in Exhibit 4.7 describes the current understanding of this project among the EPS supervisors, EPS Manager, and ASIP Director.

Exhibit 4.8 is a look at EPS business in its current state using the 7S model. It is used as a summary of the situational analysis in this project.

EXHIBIT 4.5. MBNQAA IDENTIFIED GAPS

1.0 Leadership

- Investigate 2-way communication mechanism
- **Missing employee "learning" policy
- No clear linkage of performance to company objectives
- Visibility of leader performance to employees

2.0 Strategic Planning

- **No documented requirement for strategy development

3.0 Customer and Market Focus

- Proactive process to collect customer needs data

4.0 Measurement, Analysis, and Knowledge Management

- Weak performance data availability
- Comprehensive measure matched to customer needs

5.0 Human Resource Focus

- Define "work system" for EPS
- Look at employee interaction and informal organization
- Define possible career progression
- **No policy on education/training and relevance to job
- Define support of employees within context of EPS
- No HR measures

6.0 Process Management

- Formal definition of "value " for EPS customers
- Define "value creation support processes" within EPS

7.0 Business Results

- No method to objectively collect customer data
- Only using a single performance measure RDR turn time
- No linkage between EPS and financial/market results
- Define HR results within EPS and how to measure
- Define relationship between EPS work and organizational effectiveness

EXHIBIT 4.6. EPS STAKEHOLDER LIST

Stakeholders	Influence	Roles
Stakeholder	Influence or impact on project outcome	*How might they be involved in the current initiative?*
ASIP Director	Significant	review situational analysis, define vision
Department Mngr -Champion	Critical	response on survey, idea validation, define vision
EPS Supvr - Process Owner	Critical	survey, idea development
EPS Leads	Significant	team member, survey, analysis, prioritization
EPS Engineers	Significant	survey, stakeholder analysis
Product Director	Moderate	review situational analysis, stakeholder analysis
Ops Mngrs	Minimal	stakeholder analysis
Foremen	Significant	stakeholder analysis
Inspection Supvrs	Minimal	review situational analysis
Quality Engineers	Minimal	review situational analysis

(taken directly from Textron's *TapTools v1.0*)

EXHIBIT 4.7. 15 WORD DOCUMENT

Common words/terms
"I think", "can't prove it", highly-loaded, low-margin parts, increase capacity, work smarter, this is what we did before…
Fuzzy terms/words
too many delays, need more experience, employee turn-over, bandaid repair, inappropriate repair usage
Final 15 word document
EPS will develop employees and capacity thru appropriate repairs and ecomonic value for Cessna operations.

(taken directly from Textron's *TapTools v1.0*)

EXHIBIT 4.8. SUMMARY OF EPS SITUATION (7S MODEL)

Mission	• To contribute to organizational success by delivery of cost-effective, engineered solutions to nonconforming details and assemblies for all Cessna products
Strategy	• Work safely • Deliver answers to most nonconformances within 24 hours • Apply job related learning to all – 42 hours/year • Work smarter using TSS Six Sigma tools • Allow ownership of work to reside with engineers
Skills	• Extensive fit/form/function knowledge • Inconsistent process familiarity across engineers • Balancing short term needs with long term effects
Staff	• 1 supervisor, 3 leads, 12 engineers, 3 locations
Organization Structure	• Functionally based teams
Systems	• PIOS, Online SRDRs, PQR database
Culture (Style)	• Separate functional groups

Using the descriptive information from the above tools and notes taken during manager discussions of this topic, the results of the situational analysis for EPS (current state) is as follows:

(Note: This description will be posted on the Cessna ASIP website as written below.)

"Engineering Production Support (EPS) operates much like the average Cessna Engineering group. The data entry and research involved in completing job duties is done in offices at desks utilizing networked desktop PCs and typical office software applications. Where EPS differs from other ASIP Engineering Groups is in a large portion of work time is spent on the production lines directly supporting internal customers (building components, assembly products, or troubleshooting operations). The Fast Engineering (FE) group within EPS also differs from other ASIP groups in that engineering drawings are modified with rapid turnaround. These corrective action efforts facilitate improved manufacturability and reduced paper shuffling by line personnel. This is achieved through repetitive RDR elimination, positive hardware changes to improve inventory turns, reduction in assembly man-hours, easier build-ups, and drawing error correction. Past evaluations indicate that significant customer cost-avoidance is achieved through FE efforts."

Current safety performance is zero injuries in 28,000 hours worked for 2005. Current performance indicators include at least 70.4% of RDRs answered within 24 hours and 87.1% within 72 hours (70% and 80% expected, respectively). Core competencies are conflict management, dealing with ambiguity, and organizational agility.

4.1.2 Defined EPS Future State

Direct input for the intended future state of EPS from the EPS Supervisors, EPS Manager, and ASIP Manager are bulleted below. Significant customer concerns are also listed. These statements were used in conjunction with the Textron "Visioning" TapTool (Exhibit 4.9) to help craft a description of the future EPS department.

- Ten year timeframe
- Nearly autonomous department (capable of significant stress/fatigue analysis for production issues)
- Reduce "consultations" by 50% within 5 years
- Increase nonconformance report turn-time metric from 70% to 80% within 24 hours
- Written repair instructions with more clarity – reduce reworked routers

EXHIBIT 4.9. VISIONING TOOL

What Would The Future State Look Like?	
What people would do differently…	**What the results would be…**
less calling on support groups-stress/fatigue	more analytical capability
research difficult solutions themselves	more confidence in decision-making
cooperate with shop in solution development	end result is shop has more confidence in EPS, less challenges of decision
less time spent defending dispostion	spend more time working dispositions (75% w/I 24 hours)
writing dispositions more clearly	fewer mistakes due to incomplete repair instructions

(taken directly from Textron's *TapTools v1.0*)

The envisioned future state of EPS includes more rapid entry of dispositions, possibly at the time of discrepancy review, fewer re-signs of existing nonconformances due to Inspection adding conditions or discrepancy updates, and seamless disposition of supplier nonconformances. EPS enhancements include less dependence on Stress and Fatigue groups for computations to support dispositions – reducing "consultations" by 50% through analysis done by EPS Engineers instead of Stress and Fatigue Engineers. By-products of this transformation include greater analytical-capability in EPS engineers, greater career opportunities, enhanced employee satisfaction, and better hiring practices through skills targeting.

4.1.3 Training Objective Statement

Using the situational analysis above, management of EPS chose to develop a training objective statement that would be generic for the EPS groups and easy to tailor to the individual engineer on his or her yearly Performance Management Process. The EPS training objective statement builds upon the company-wide training requirement to include reference the knowledge, skills, and abilities identified in the next section. The EPS training initiative is as follows:

- The EPS Engineer will obtain 40 hours job-relevant training each year. Training will be chosen to enhance the engineer's technical competence (impact prioritized KSAs as assessed by individual and immediate supervisor) and directly reduce the average time for nonconformance answer as measured by the CMF EPS KPI (70% or more of nonconformances answered within 24 hours).

4.2 SKILLS PROFILE

The envisioned future of EPS includes new skills that will require training. The point of this section is to present the current and future skills comparison needed to understand potential future performance gaps and prioritize identified KSAs. Most exhibits for this section are only included in Appendix D as the large size of the tables makes presentation in this section cumbersome.

4.2.1 KSAs Critical to Future EPS

This subsection presents the CMF EPS prioritized skills profile developed using strategic skills analysis.

4.2.1.1 Task Analysis Results

Recall from section 3.2.1.1 that the expected result from performing a task analysis is a database of KSAs key in performing the task. The list of typical nonconformance types discerned from the series of meetings between EPS leads and engineers is presented in Appendix D, Exhibit D.1 - First pass KSA collection for CMF EPS. This listing illustrates normal nonconformances encountered across the CMF spectrum of operations and includes the specific first pass KSAs used in dealing with a nonconformance of the identified type. Next, similar first pass KSAs were condensed into subject families. These seventy-five (75) condensed KSAs are described in Exhibit D.2. Exhibit D.3 shows the condensed knowledge, skills, or abilities that are applicable to the identified nonconformance types from Exhibit D.1. Exhibit D.3 is the disposition development task KSA database and output from the task analysis.

4.2.1.2 Prioritized KSAs Results

Survey responses were received from 100% of requested participants (17 of 17) for the perceived criticality of the 75 KSAs to disposition development and frequency of KSA use. Raw data from the engineers is compiled in Appendix D, Exhibit D.4 (criticality) and D.5 (frequency of use). No write-in data was received. Blanks indicate raters who believed they could not respond to criticality or frequency due to lack of experience with the listed knowledge, skill, or ability and are not included in computations.

The perceived importance value for each listed KSA is presented Exhibit D.6. The importance value is the average of each engineer's criticality rating times frequency of use rating (column "Importance"). The higher the value the more important the KSA is to disposition development. Each table presents the data in index order of knowledge, skill, or ability. The "Rank Order (current)" column value indicates the perceived importance ratings in rank order. Exhibit D.6 is the prioritized current state KSA database result for the SSA.

4.2.1.3 Updated Prioritized KSAs Results

Recall from section 3.2.1.3 that the process of identifying KSAs via task analysis would be repeated using input from five current stress engineers and three current fatigue engineers. The two support items the stress and fatigue engineers help EPS with are Stress and Fatigue Analysis. The associated list of KSAs used in those analyses is included at the end of Exhibit D.1 - First pass KSA collection for CMF EPS. Next, similar first pass KSAs were condensed into twenty

(20) subject families. These condensed KSAs are described in Exhibit D.2 and included with the current KSA descriptions. Exhibit D.3 shows the condensed knowledge, skills, or ability applicable to Stress or Fatigue Analysis, including current KSAs used in those analyses.

Survey responses were received from 100% of requested participants (4 of 4) for the perceived criticality of KSA to future disposition development and future frequency of KSA use. These 20 KSAs are those unique to future disposition development that today would require Stress or Fatigue Engineer support. Raw data from the engineers is compiled in Appendix D, Exhibit D.4 (criticality) and D.5 (frequency of use). No write-in data was received.

The perceived importance value for each future KSA is presented at the end of Exhibit D.6. The importance value is the average of each engineer's criticality rating times frequency of use rating (column "Importance"). The higher the value the more important the KSA is to future disposition development. Each table presents the data in index order of knowledge, skill, or ability. The "Rank Order (future)" column value indicates the perceived importance ratings in rank order. Exhibit 4.10 is the prioritized KSA database or EPS skills profile in order of importance.

EXHIBIT 4.10. PRIORITIZED SKILLS PROFILE

K, S, or A	Index	Name	Importance (Average C*F)	Rank Order (current)	Rank Order (future)
K	111	Physics of aircraft	22.75		1
K	109	Mechanics of materials	21.50		2
S	11	Interpret eng dwg	19.63	1	3
K	34	Part or assy fit/form/function	19.56	2	4
K	14	Fasteners (permanent)	19.50	3	5
K	106	Fatigue basics	19.25		6
K	112	Stress basics	19.25		6
A	3	Discern affects on fit/form/function	18.75	4	8
K	16	Finish Codes	16.47	5	9
S	3	Determining load path	16.43	6	10
S	101	Basic stress analysis	16.25		11
A	6	Locate info in manuals/specs	16.20	7	12
S	5	General math	15.56	8	13
S	13	OPSS Reading	15.38	9	14
K	101	Analysis Tools	15.00		15
A	1	Analyze effects on part configuration	14.82	10	16
K	110	MMPDS (Mil-Hdbk-5G)	14.50		17
K	15	Fasteners (removable)	14.44	11	18
K	105	Fatigue critical locations by model	13.50		19
S	1	Determine damage cause	13.13	12	20
K	11	Dissimilar Mat'ls & Galvanic Action	13.00	13	21
A	10	Use of precision measuring instruments	12.94	14	22
K	19	Heat treatments	12.38	15	23
K	31	Metals behavior	12.25	16	24
K	29	Mat'l Damage Removal	12.13	17	25
K	23	Laminate rework	12.09	18	26
K	8	Composite laminates manufacturing	12.00	19	27
K	20	Hydrogen Embrittlement	11.58	20	28
K	33	NDI Processes	11.27	21	29
K	38	Primer	11.21	22	30
K	37	Plating/electro-depositing	11.08	23	31
K	18	Forming Practices	10.57	24	32
A	102	Locate appropriate info in reports	10.50		33
K	32	Metals properties	10.44	25	34
K	30	Mat'l Substitution	10.38	26	35
K	25	Machine shop practices	10.33	27	36
K	4	Chemfilm	10.29	28	37
K	108	Margin of safety	10.25		38
K	22	Laminate Mat'ls	10.00	29	39
K	49	Weld processes	9.69	30	40
K	39	REX-grain	9.64	31	41
K	5	Cleaning mat'ls	9.60	32	42
S	8	ID REX-grain	9.55	33	43
K	12	Engineering Drawing practices/stds	9.44	34	44
K	10	Cure cycle	9.38	35	45
K	104	FAR Requirements	9.25		46
K	21	Laminate loading	9.09	36	47

K, S, or A	Index	Name	Importance (Average C*F)	Rank Order (current)	Rank Order (future)
K	26	Machining practices	9.00	37	48
S	9	ID visible mat'l defect	9.00	37	48
S	12	Interpret forging dwgs	9.00	37	48
K	103	Crack Initiation Characteristics	9.00		48
K	1	Anodize	8.93	40	52
S	10	Interpret casting dwgs	8.91	41	53
K	17	Forging	8.77	42	54
A	8	Read Lab Test Results	8.33	43	55
K	3	Castings	8.18	44	56
A	5	Inspect Welds	8.07	45	57
K	7	Cold Bonding	8.07	46	58
S	4	Differentiate among mat'ls	8.00	47	59
K	50	Weld symbols	7.86	48	60
K	45	Thermosetting	7.60	49	61
K	40	Sealers	7.56	50	62
S	2	Determine weld joint type	7.50	51	63
S	102	Fatigue software	7.50		63
K	47	Transparency Inspection	7.45	52	65
K	44	Staking Operations	7.38	53	66
K	28	Mat'l Cutting	7.14	54	67
K	43	Shop practices	7.07	55	68
S	105	Stress software	7.00		69
A	101	Interpret test results	7.00		69
K	102	Cold Expansion Process	7.00		69
K	24	Lubricant coats	6.93	56	72
K	27	Masking for etch	6.93	57	73
S	7	ID good v bad mat'l edge	6.79	58	74
S	104	Kt Values	6.75		75
K	35	Peening	6.69	59	76
K	13	Extrusion Procurement Reqm'ts	6.50	60	77
K	2	Case Hardening	6.46	61	78
K	9	Composite tooling prep	6.36	62	79
K	42	Sheet mat'l quality	6.23	63	80
K	46	Topcoats (Finishes)	6.07	64	81
K	41	Sheet mat'l procurement Reqm'ts	5.85	65	82
A	9	Review SCDs	5.71	66	83
S	6	ID approximate surface roughness	5.50	67	84
S	15	Reading PowerView output	5.30	68	85
A	2	Communicating with Buyers/Suppliers	5.23	69	86
S	14	Read oven/autoclave data	5.15	70	87
K	36	Plastic Welding	4.75	71	88
K	107	FEM Principles	4.75		88
K	48	Vendor Codes	4.55	72	90
A	103	Use of analysis texts	4.50		91
K	6	CMM	3.69	73	92
A	4	Ergonomic Lifting	3.69	74	93
S	103	FEM	3.00		94
A	7	Radius gage usage	2.33	75	95

4.2.2 Estimated Budget for Training Delivery

Exhibit 4.11 illustrates the estimated cost of training course development for the top ten KSAs ranked by future importance to disposition development. This $894,000 cost is figured from survey responses for estimated training hours (average) required to be proficient in the knowledge, skill, or ability multiplied by course development cost from Exhibit 3.8. Exhibit D.7 presents the raw data collected from the survey.

Survey responses were received from 53% of requested participants (9 of 17) for current KSA training hours and 75% of requested participants (3 of 4) for future KSA training hours. Blanks indicate raters who believed they could not respond to estimated training hours required for basic proficiency or who responded with non-hour values.

EXHIBIT 4.11. TOP TEN PRIORITIZED KSAS ESTIMATED TRAINING AND DELIVERY METHOD

KSA		Rank Order (future)	Estimated Trng (hrs)	Delivery Media	Cost	Why Delivery Choice?
K 111	Physics of aircraft	1	67.67	ILT-Classroom	135,000	Trainees need in-depth understanding, must ask active questions, extensive use of props. However, not collocated - multiple sessions, many locations.
K 109	Mechanics of materials	2	47.00	50% CBT / 50% ILT Class/Virtual	165,000	Significantly stable material, but key in developing understanding is application practice and question answering.
S 11	Interpret eng dwg	3	26.78	WBT	134,000	Stable content, structured delivery with a large audience who are not collocated, but are generally technology proficient.
K 34	Part or assy fit/form/function	4	29.00	ILT-Classroom	58,000	Trainees need in-depth understanding, must ask active questions, extensive use of props. However, not collocated - multiple sessions, many locations.
K 14	Fasteners (permanent)	5	31.88	75% WBT / 25% ILT Class	135,000	Much stable and structured content. Some modeling and practice are needed for proficiency
K 106	Fatigue basics	6	14.00	WBT	70,000	Stable content, structured delivery with a large audience who are not collocated, but are generally technology proficient.
K 112	Stress basics	6	8.00	WBT	40,000	Stable content, structured delivery with a large audience who are not collocated, but are generally technology proficient.
A 3	Discern affects on fit/form/function	8	38.63	ILT-Classroom	77,000	Trainees need in-depth understanding, must ask active questions, extensive use of props. However, not collocated - multiple sessions, many locations.
K 16	Finish Codes	9	5.33	WBT	27,000	Stable content, structured delivery with a large audience who are not collocated, but are generally technology proficient.
S 3	Determining load path	10	26.50	ILT-Classroom	53,000	Trainees need in-depth understanding of complex subject, must ask active questions, extensive use of props. However, not collocated - multiple sessions in many locations.
			Total		$894,000	

5.0 CONCLUSIONS

The intent of this project was to lay a foundation for technical skills improvement for Components Manufacturing Facility EPS groups. Future autonomous operations will require skill improvements. To facilitate the start of this skills improvement effort, a training objective statement was developed and a strategic skills analysis was performed to identify the future EPS Engineer skills profile. This section presents the conclusions drawn from the SSA for CMF EPS.

5.1 TRAINING OBJECTIVE

The EPS training objective is reprinted below. The process used in development of the EPS training objective statement greatly increased the author's communication with departmental supervision. With the increased communication came increased visibility and understanding of departmental effectiveness. The situational analysis helped create awareness of customer needs and a common list of stakeholders among the CMF EPS group leads, supervisor, manager, and ASIP Director.

- The EPS Engineer will obtain 40 hours job-relevant training each year. Training will be chosen to enhance the engineer's technical competence (impact prioritized KSAs as assessed by individual and immediate supervisor) and directly reduce the average time for nonconformance answer as measured by the CMF EPS KPI (70% or more of nonconformances answered within 24 hours).

Although the individual engineer may not see direct advantages in the training objective statement above, its use may have impact if the individual and supervisor apply it during the PMP reviews. Targeted training to improve skills, not just fill a mandated training hour quota, will result in small but effective changes in the way work is performed in EPS.

Limitations. A limitation of the training objective statement is lack of emphasis on business results for EPS customers. While the intent of the objective is to help drive choice of effective training by the individual engineer to build skills, alternate effects may occur. Training behavior must be effectively monitored and effects on customer metrics need to be tracked, if possible.

5.2 SKILLS PROFILE

The Strategic Skills Analysis was successfully performed on the CMF EPS groups. The result is a prioritized skills profile, Exhibit 4.10, for the future evolution of this Cessna Engineering department.

5.2.1 Strategic Skills Analysis

This is an effective way to prepare a group or team for change. Performing the SSA and sharing the results may be a consensus builder in understanding the need for change and explaining future work expectations. The future KSA importance ranking is similar to the current KSA importance ranking. The addition of four (4) future KSAs to the top ten KSAs prioritized indicates a need to develop greater analytical capability in EPS Engineers similar to the current capabilities of the Stress and Fatigue Engineers.

The number one and number ten ranked KSAs, "Physics of Aircraft" and "Determining Load Path," respectively, are closely related knowledge and skills. As are the number four KSA, "Part or assembly fit/form/function" and number eight KSA, "Discern affects on fit/form/function." Several other KSAs are related in application of knowledge as a skill or ability. It appears that the 75 unique KSAs identified could be further grouped for training purposes into families of knowledge, skills, or abilities. This technique may enhance training effectiveness by providing application practice of advanced knowledge.

Limitations. It must be noted that this SSA was performed only with input from current Components Manufacturing Facility engineers. It is not directly applicable to the other two EPS sections or other engineering groups without full replication. Another major limitation not addressed in this project is an actual skills assessment – proficiency check. Also, to supplement the perception ratings in Exhibits D.4 and D.5, a mini-study on KSA usage should be performed to confirm or deny the values obtained. This recommendation results from the range of values received from respondents for a given KSA. Many KSA ratings were consistent across all raters while some fluctuated wildly to the extremes of the scale. This could be attributed to lack of complete understanding of the KSA to be rated or lack of experience in EPS. Follow-up studies may show bias by experience level or worker assignment.

5.2.2 Training Delivery Mechanisms

The available Cessna training delivery mechanisms were identified based upon conference room equipment listings and Cessna Learning and Development Department input. Appropriate delivery media for the top ten prioritized KSAs from the SSA were chosen by the author based on the contents of Exhibit 3.9, Delivery application table.

Limitations. Discussions with Cessna's Learning and Development Department have limited course delivery media. The majority of training courses developed by employees to be delivered to other employees will continue to be delivered via Classroom ILT for collocated employees. Those employees in other locations will be presented with Classroom ILT when possible (convenient for instructor) or via WBT. The WBT content will be taped audio from the original Classroom ILT presented over timed slides. Efforts must be undertaken to improve the delivery media scheme for all courses. A one-size fits all approach is not effective at obtaining results from training. This method may be convenient and/or cheap, but it is neither capable of delivering results on the initial investment nor does it take into account learner preferences and needs for training.

5.2.3 Estimated Training Budget

The cost estimate of the top ten KSA courses in Exhibit 4.11 was developed to illustrate the high cost of developing true training courses for EPS. Developing ten courses per year may be an aggressive estimate for the available training resources. However, once the course material has been developed, it can be reused over time to reap the benefits of the investment.

Limitations. Other training delivery mechanisms or course content development methods exist. Potential methods are listed in Exhibit 5.1. These methods of training delivery or content development need investigation to determine if there is a cost and/or quality of training advantage over developing course material from scratch for employee instructor to employee training.

EXHIBIT 5.1. LIST OF AVAILABLE TRAINING MECHANISMS

- canned or purchased programs
- college courses
- consultant programs
- independent study
- job embedded
- training by supervisor

5.3 SIGNIFICANT FINDINGS

The EPS Engineers involved in this project was surprised at the number of separate knowledge, skills, and abilities identified. Also surprising was the lack of analysis skills that EPS uses on a daily basis. Loads of technical knowledge and process familiarity were identified, but few practically applied technical skills/abilities. Abilities to differentiate between attribute characteristics “good” and “bad” need further definition and quantification for conversion into technical knowledge or skills training.

The EPS Manager and ASIP Director were somewhat surprised at how independent EPS operations are from regulatory requirements. That is, how little knowledge of the FARs EPS uses. It was suggested that a separate knowledge of regulations course be developed complement the future stress and fatigue KSAs. The purpose of this course would be to introduce the EPS Engineer to the federal codes that most of Cessna’s designs and analyses are derived from. Everything in the design and manufacture of Cessna products stems from some lawful requirement and the linkage from code to engineering drawing to test results or analysis should be understood. This understanding can be used to facilitate greater creativity in answering nonconformances.

Two quotes from participating EPS Engineers summarize the prioritized skill profile; “We are truly jacks-of-all trades in this work” and “knowing when you don’t know enough is the key to success.” The skills profile supports the first statement and the identified future KSAs support the second.

6.0 SUGGESTIONS FOR FOLLOW-ON WORK

Several topics needing further analysis were found during the efforts of building this field project. All the topics discovered would have made great additions to this work, however, project scope and schedule would have suffered greatly with the additional topics. This section will report on the most worthy of these topics.

6.1 KNOWLEDGE, SKILL, AND ABILITY ASSESSMENT

A common theme among the literature on developing training materials is an understanding of where the students are starting from – current level of proficiency, etc. Even the American education system has significant emphasis on proper educational placement of all students.

If the course content is significantly above the participant's understanding of the subject, the attendee may "buy-out" (actively disengage from the training) while encouraging others to the same. Similarly, if the content is below the participant's experience level, the training will, at best, be a refresher course with little value to the employee or company. Content well below the attendee's proficiency level will simply be lost productive time for the instructor and trainee(s). The importance of assessment on existing proficiency should be researched to fully appreciate the effects on trainee involvement and knowledge transfer.

In addition, a follow-up mechanism should be instituted to check the retention of knowledge. Methods of post-training assessment need research to discover the simple, but effective methods for measurement of KSA transfer.

6.2 DEVELOPMENT OF COURSE CONTENT

Content for employee-delivered training courses have always been a topic of discussion within the rank of Cessna. As a large company, Cessna employs many experts in many subjects. The management of most Cessna departments does not feel it necessary to hire professional trainers or use professionally developed content. The expectation that employees pass knowledge on to other employees who need it is perfectly acceptable – provided the person doing the training is willing, able, and competent at *teaching*. Content of courses has historically been lacking in technical training. Typical classroom courses lasting an hour or so are a tremendous burden to be placed upon professionals who do not normally develop course content.

Time expended for course development by the non-teaching professional is quite inefficient and often results in monotonous instructor dominated information sessions. The estimated 40 hours it takes to generate one hour of course content is too great for the typical duty-laden engineer to reserve. A trade-off study should be commissioned concerning cost to Cessna for employees to develop true training course content versus off the shelf courses of University short course cost.

6.3 Instructor Qualifications

Another subject for follow-on research is instructor qualification. For a group of educated engineers to accept training (buy-in) from an instructor requires some level of expertise exhibited by the instructor and respect by the participants (especially a fellow employee). ASIP and/or Cessna may want to invest in a program to identify technically qualified experts in the subjects desired. This could be considered a form of benchmarking to recommend best practices for the technical activities to be taught. This could result in a decreased time to proficiency by the trainee.

6.4 Training Retention Improvement

A serious concern from many employees has been that current training efforts have resulted in boring sessions with an incomplete picture communicated. An in-depth review of teaching methods is needed to pinpoint where instructor/employees could most effectively enhance their teaching skills. Teaching and imparting knowledge is more than communicating effectively; it is managing the interaction of teacher and students to actively involve the participants. Train the trainer sessions would likely improve engagement of the participants and knowledge retention (recall Exhibit 3.6, Learner retention rates).

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APPENDIX A

The following is a paragraph from the Code of Federal Regulations, Title 14, Part 21 (NARA, 2005), interpreted as the requirement for an aircraft manufacturer to have a system in place for handling nonconforming materials during the manufacture of aerospace vehicles. This text was copied directly from the site listed on the Reference page.

Title 14: Aeronautics and Space
PART 21—CERTIFICATION PROCEDURES FOR PRODUCTS AND PARTS
Subpart F—Production Under Type Certificate Only

§ 21.125 Production inspection system: Materials Review Board.

(a) Each manufacturer required to establish a production inspection system by §21.123(c) shall—
(1) Establish a Materials Review Board (to include representatives from the inspection and engineering departments) and materials review procedures; and
(2) Maintain complete records of Materials Review Board action for at least two years.
(b) The production inspection system required in §21.123(c) must provide a means for determining at least the following:
(1) Incoming materials, and bought or subcontracted parts, used in the finished product must be as specified in the type design data, or must be suitable equivalents.
(2) Incoming materials, and bought or subcontracted parts, must be properly identified if their physical or chemical properties cannot be readily and accurately determined.
(3) Materials subject to damage and deterioration must be suitably stored and adequately protected.
(4) Processes affecting the quality and safety of the finished product must be accomplished in accordance with acceptable industry or United States specifications.
(5) Parts and components in process must be inspected for conformity with the type design data at points in production where accurate determinations can be made.
(6) Current design drawings must be readily available to manufacturing and inspection personnel, and used when necessary.
(7) Design changes, including material substitutions, must be controlled and approved before being incorporated in the finished product.
(8) Rejected materials and parts must be segregated and identified in a manner that precludes installation in the finished product.
(9) Materials and parts that are withheld because of departures from design data or specifications, and that are to be considered for installation in the finished product, must be processed through the Materials Review Board. Those materials and parts determined by the Board to be serviceable must be properly identified and reinspected if rework or repair is necessary. Materials and parts rejected by the Board must be marked and disposed of to ensure that they are not incorporated in the final product.
(10) Inspection records must be maintained, identified with the completed product where practicable, and retained by the manufacturer for at least two years.

APPENDIX B

The following is a reprint of the Training Plan section and Roadmap from the *Engineering Production Support Handbook* (Cessna, 2002).

6.0 TRAINING PLAN

At the start of the training phase, the coach and trainee should develop, agree upon, and review a training plan. Following a plan helps ensure training integrity. Because the Engineering Production Support Roadmap Competencies and Cross Training are listed in a generic chronological order (by area) the training plan uses the Roadmaps as the training guide.

6.1 Timeline

This subsection details the approximate time periods to complete the various sections of the Roadmap and reviews to be completed by the coach and supervisor.

End of month since hire date

Milestones	1	2	3	4	5	6	7	8	9	10	11	12
Engineering Orientation												
Complete Roadmap												
Basic Cessna Knowledge												
Roles & Responsibilities												
Basic Engineering												
Engineering Production Support												
Fast Engineering												
Cross-training												
Active MRB Participant												
Progress Checks												
New hire												
3 month check-up												
6 month check-up												
11 month check-up												
Submit MRB Approval App.												

6.2 Progress Checks

Occasional planned progress checks should be made to determine the new Production Support Engineer's progress on the Roadmap and to check development. This is an excellent time for the coach, supervisor, and trainee to get together for a question and answer session. The progress check should not be used as a tool to measure the new hire's performance. It is to be used as a working session to determine placement on the Roadmap and adjust the training plan to meet the individual needs of the trainee.

Within the first month from the new employee's start date or transfer date, the supervisor or coach should schedule a short information meeting to discuss the new hire's expected progress and to review the training plan and time line. This session can be used to communicate expectations about attitude, work ethic, and typical development patterns. The trainee is encouraged to be actively involved by asking questions and speaking frankly about his or her experiences.

Progress checks should be initiated by the coach or supervisor at approximately 3 month intervals or as needed to facilitate as much communication as possible among the trainee, coach, and supervisor. It is imperative that the 11 month progress check-up be accomplished on schedule. This gives the coach and supervisor adequate time to evaluate the new team member's performance just prior to submitting the MRB Approval documents.

6.3 Learning Projects

In the interest of various learning styles, the coach should plan for a few hands-on learning exercises for the trainee. These projects can be especially helpful during the first 3-6 months of development.

Examples are

- Work area map
- Fastener example chart – hardboard/visual aid
- Composite repair recital
- Conical washer process
- Removed rivet examples – good/bad/ugly
- MRB terminology definitions
- Project/Stress/Fatigue contacts
- Little known PIOS facts
- Bonding examples – Class A thru D
- Or just about any other short-term project with learning potential

APPENDIX C

The following is a sample survey used to collect engineer's rating of criticality to disposition development and frequency of usage.

Nonconformance KSA Survey Instrument

Job: Engineering Production Support
Duty: Answer Nonconformance
Task: Develop Disposition
Purpose: To aid in understanding the usage of Knowledge, Skills, Abilities (KSA) required for your job. Attached for reference is the worksheet "Job Analysis_KSAs" which lists KSAs used with which types of nonconformances.
Instructions: The "KSAs" worksheet contains a list of Knowledge (K), Skills (S), and Abilities (A) relating to the typical nonconformances answered in your job. There is also an explanation of the K, S, or A to help with the rating. Beside each KSA is a section to rec

1. The **criticality** of the KSA for the successful disposition of the nonconformance. There are 5 levels, input the number of the level that you believe best describes the KSA:
   1) Not important
   2) Less important
   3) Somewhat important
   4) Important
   5) Most important
2. The **frequency** the KSA is used in your dispositioning - Record it using the following scale:
   1) Almost never
   2) Less often
   3) Weekly
   4) Daily
   5) Hourly
3. The amount of **training required** to reach proficiency - Enter the number of hours that you believe it would take a new hire to become proficient in the job. It is best to use the total amount of training that you received for you to become proficient.
4. If you feel some subjects were not covered, please use the **write-in** space at the bottom of the KSA listing to describe the KSA.

Reference: This survey instrument is a modified version of Don Clark's "Task Survey Instrument" taken from *Analysis Template Book* (2001).

Knowledge (K), Skill (S), or Ability (A)	Index	Name	Explanation of K, S, or A	Criticality	Frequency	Training Required
A	1	Analyze effects on part configuration	Convert stated defects into part/assembly configuration change			
A	2	Communicating with Buyers/Suppliers	Purchaser identification and contact practices, what information buyer can obtain, What to/what not to say, who to call, which buyer to go to			
A	3	Discern affects on fit/form/function	How will part usage be affected by the disc.?			
A	4	Ergonomic Lifting	Lift and hold up to 40# for 30s			
A	5	Inspect Welds	Determine weld quality visually - relate stated defect into visual representation			
A	6	Locate info in manuals/specs	Physically finding info in product catalogs or specifications that is useful to disposition or discrepancy review			
A	7	Radius gage usage	Ability to properly use radius gages (verify stated fillet/radius size)			
A	8	Read Lab Test Results	Knowledge and skill interpreting LTR results - who to ask when unclear			
A	9	Review SCDs	Review of product reqm'ts			
A	10	Use of precision measuring instruments	Using and reading micrometers, calipers, vernier devices, profilometer, scale, and other measuring devices			
K	1	Anodize	Color and hard coat, how it is done, why, benefits, limitations, Specs. . .			
K	2	Case Hardening	Purpose and applications for case hardening			
K	3	Castings	Basics of casting (How it is done), mat'ls used, term definitions, the why of radiography, CSTI004 Casting Reqm'ts, CSPS064, Weld Repair			
K	4	Chemfilm	Purpose and applications of chemfilm and magnesium protection, effects of acid entrapment, how to chemfilm, environmental concerns, CSFS027, 034			
K	5	Cleaning mat'ls	Abrasive cleaning practices, mat'l applications, limitations, CSFS037, chemical cleaning applications (de-ox, alkaline, etch, pickle/passivate), effects of, effects on mat'ls, masking, CSFS035, 044, 045, CSTI002			
K	6	CMM	Applications for CMM output, how to, how it works, basics of CMM			

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APPENDIX D

The following is the raw data collected in this project concerning CMF EPS skills.

EXHIBIT D.1. FIRST PASS KSA COLLECTION FOR CMF EPS

JOB							
	Duty						
		Task					
			Major Category of Nonconformance				
				Process/NC Component			
					Knowledge of	Skill in	Ability to
PRODUCTION SUPPORT ENGINEER							
	Answer Nonconformance						
		Develop Disposition					
			Assembly				
				Corrosion protection	CSFS031, Dissimilar Metals	Interpreting specs/practical applicat	Locate information in specs/manuals
					galvanic action		
					Finishes and effects on galvanic action		
					FAR 25.609		
				Finishes	FAR 25.609	General math for dimensional analys	Locate information in specs/manuals
					CSFS001, A/C Finish Codes (related specs)		
					epoxy primer		
					chromate primer		
					topcoats		
					CSMP004 for H.E.		
					CSNP035, Sealers		
				Cold bond	CSNP021, Adhesives		Locate information in specs/manuals
					Adhesive applications		
					Fit/form/function of assembly		
				Damaged fasteners	CSMP051, Rivets	Equivalent fastener analysis	Locate information in specs/manuals
					CSMP028, Hi-Loks, Lockbolts, Thread	Fastener failure mode analysis	Fastener Code book usage
					CSMP052, Blind fasteners	ASIP fastener strength dB	
					CSMP053, Csk, Dimples	crack growth analysis	
					General mat'ls and fastener interactions		
				Mat'l damage	Mat'l blending methods	Distinguishing damage type	
					Fit/form/function of assembly		
				Poor dwg callout	Engineer dwg practices/stds	Cessna dwg reading	Interpreting dwg meaning
				Missing parts	Fit/form/function of assembly	Cessna dwg reading	Interpreting dwg
							Interpreting P/L or BOM
				Missed ops	OPSS stds	Cessna dwg reading	Interpreting P/L or BOM
					Missed ops affects		
					Shop practices		
				Incorrect supplier parts	Vendor codes	Translating vendor reqm'ts to Cessn	Analyze effects due to part
					Buyer codes		
				Bearing Staking	NAS0331		
					CSMP023, Staking		
					Behavior of Metals		
					Damage Tolerance of metals		
			Composites				
				Cocure/Secondary bond	Cure cycle		Locate information in specs/manuals
					Composite specs, CSAC001-008		
					Composite mat'ls, CMACs		
					Composite load carrying characteristics		
					CSNP011, Rework Stds		
					CSNPxxx, Adhesives		
				Layup	Fabric/tape behavior	Cessna dwg reading	
					Tool prep		
					Mat'l substitutions		
				Core/potting	CMAC001, Core Mat'l		Locate information in specs/manuals
					Core/adhesive behavior		
					Potting techniques		
					Structural characteristics		

(Exhibit D.1 continued)

		Knowledge of	Skill in	Ability to
		Knowledge of	Skill in	Ability to
	Bagging	Bagging techniques/mat'l uses		
	Cure cycle	Composite specs, CSAC001-008		
		Composite mat'ls, thermosetting, CMACs		
	Cold bond	S/A Assembly	*	*
	Fit issues	Layup techniques		
		Trim methods		
		Assembly processes		
	Handling damage	Generic composite repair methods	Discern cause of defect	
		S/A Cocure/secondary bond		
	Mat'l NC	Composite specs, CSAC001-008		Visually detect good/bad variation
	(weave, resin contents, ou	Composite mat'ls, CMACs		
		Fit/form/function of assembly		
Finishes		CSFS031, Disimilar mat'ls		
	Cadmium plate	CSFS024/026, Cad plate		Locate information in specs/manuals
		CSFS028, Ti-CAD plating		
		Industry stds, QQA-416		
		Metal behavior-high strength alloys		
		M&P 99-87-053, ???		
		CSMP004, Heat Treat of Steels		
	Shotpeen	CSMP027/045, Peen, Peen forming		Locate information in specs/manuals
		Shop practices		
	Prime (epoxy/zinc)	CSFS001, A/C Finish Codes		Locate information in specs/manuals
		Paint mat'l handling		
		Spray applications & limits		
		CMFS029/084		
		CSFS007		
	Chemfilm	CSFS027, Chemfilm		Locate information in specs/manuals
		Acid entrapment effects		
		CSFS034, Magnesium Chromate Conversion		
	Chrome/Nickel Plate	CSFS029		Locate information in specs/manuals
		MIL-C-26074, Nickel Plate		
		ASTM B571, Plate Testing		
		Mil-Std-171, Decorative Chrome		
		Applications of Metal Protection		
		Behavior of metals		
	Heat treat	Heat treat of metals, CSMP003/004/04	Visually differentiate among metals	Locate information in specs/manuals
		Behavior of metals	Interpreting oven charts and effects on heat treat	
		Hydrogen embrittlement		
		Tempering		
		Hardness		
		CSPS026/027		
		Case Hardening		
	Abrasive Cleaning	CSFS037, Cleaning mat'ls		
		Abrasive media applications		
		Smooth and blend methods		
	Chemical Cleaning	CSNP035,Alkaline clean		Locate information in specs/manuals
		CSFS044		
		CSFS035		
		CSFS045		
		Applications of chem clean		
		Effects on mat'ls		
		De-ox, Etch, pickle/passivate		
	Powder Coat	CSFS0xx, Powder coat		
		Powder coat applications		
		How to powder coat		
		Defect causes, powder coat		

(Exhibit D.1 continued)

		Knowledge of	Skill in	Ability to
Formed Parts				
	Brake/Hydroforming	CSMP017, Forming Practices		Radius gage usage
		Conditioning Alloys		
		Mat'l behavior		
		Hydro ops		
		Check and straighten		
		Trim ops		
	Chem-mill	CSTI002, Masking		
		Acids/etchants (Chemical Cleaning)		
	Lasercut	CSMP049		
		Recast of metals		
		Behavior of metals-Crack initiation		
	Mat'l Profiling	Metal cut ops/machining		
	Deburr	Metal cut ops/machining	ID good v bad deburr	
	Stretch	Behavior of metals	Differentiate between orange peel/ludering	
		CSMP017, Forming Practices		
		CMMP019, Mat'l Quality		
	Wrong tool	Fit/Form/Function		Analyze effects due to config
	CGNT/MDM Issues	Fit/Form/Function		Analyze effects due to config
				Interpreting dwg meaning
Machined Parts				
	Deburr	Metal cut ops/machining	ID good v bad deburr	Ergonomic lifting up to 40#
	Machining, hone, grind, (	CSMP024, Machine Practices	Reading eng dwgs	Use of precision measuring equipment
		Shop practices	General math for dimensional analys	Use of profilometer
		Basics of CMM	Reading Forging drawings	
		Machine applications		
		Behavior of metals		
		Mat'l physics		
		Mat'l properties		
	Damage-handling/corros	Mat'l blending methods	Determining load path	Analyze effects due to config
		Finishing processes	Determining cause of damage	
		CSFS031, Disimilar Metals		
		Galvanic action		
	Forging	CMMP027/028, CSTI023/025/034	Reading Forging drawings	Ergonomic lifting up to 40#
		Part fit/form/function	ID REX grain	
	Casting	CSTI004, Casting reqm'ts	Reading casting dwgs	Supplier communications
		CSPS064, Casting weld repair	ID surface roughness	Interpreting supplier/Cessna agreemen
		RT knowledge		
		Part fit/form/function		
	Dimensional	Part fit/form/function	General math	Discerning affects on fit/form/function
			Eng dwg interpreting	
	REX grain	Behavior of metals	Reading Forging drawings	Detect presence of REX
		Affect of REX on mat'l properties		Ergonomic lifting up to 40#
		Mat'l physics		
Plastics				
	Optics distortion check	CSTI013	Eng dwg interpreting	Locate information in specs/manuals
		SCDs	Visually detect changes in view	
		Use of the grid system	PowerView output reading	
		Optics definitions		
	Thermoforming	CSNP001/006, Thermosetting Laminates		Locate information in specs/manuals
		Part fit/form/function		
		Plastic welding		

(Exhibit D.1 continued)

		Knowledge of	Skill in	Ability to
Raw Mat'l				
	Corrosion	CSFS031, Dissimilar Metals	S/A in Assembly, Finishes	
		galvanic action		
		FAR 25.609		
	nonQPL	CSTI036		Locate information in specs/manuals
		CMMP025		
		CSRS020		
		QAM/spec reqm'ts		
	No cert	QAM/spec reqm'ts		Locate information in specs/manuals
	No coupons	CMMP025		Locate information in specs/manuals
	Alternate mat'ls	Behavior of mat'ls		
		Science of mat'ls		
	Sealer	CMNP021, CSNP035 Sealer and how t	Interpret lab test requests	Locate information in specs/manuals
		Mat'l usage reqm'ts		
Welding				
	Casting	CSTI004, Casting Inspection	Reading casting dwgs	Supplier communications
		Casting process	ID surface roughness	Interpreting supplier/Cessna agreemen
		Casting mat'ls used		
		CSPS062, Weld repair		
	Weld issue	AWS A2.4, Weld symbols	Detect weld joint type	Visually inspect weld
		Weldable alloys, mat'l science		Locate information in specs/manuals
		Weld processes		Choose correct weld symbol
		Cleaning of metals		
		Brazing		
		CSMP039, Fusion Welding		
		CSMP009, Brazing		
		Heat treat of metals, CSMP003/004/047		
General				
		NDI Processes		
		Mat'l Science		
Additional capabilities under autonomous ops				
	Stress Analysis	Physics of aircraft	Cracks 95 (bypass, bearing, transfer	Locate appropriate info in Reports (loa
	&	Statics	Determining Kt values and meaning	Locate analysis texts
	Fatigue Analysis	Mechanics of Mat'ls	Basic stress analysis	Understand test results
		FEM Principals	Mc/I + P/A	Undersand test database
		Margin of safety computations	Bending	
		Mil Handbook usage/contents	Shear	
		Fatigue rules of thumb	Torsion	
		Stress rules of thumb	Bearing	
		Fatigue critical locations by model	Joint strength analysis	
		Primary structure	FEM	
		FAR Reqm'ts	Stress software package	
		Fatigue interaction with metal bond	Loads characteristics	
		shop practices	Interpreting test results (s/f)	
		Part fit/form/function	Interpret texts (Bruhn/Niu…)	

EXHIBIT D.2. KSA GLOSSARY

Knowledge (K), Skill (S), or Ability (A)	Index	Name	Explanation of K, S, or A
Current KSAs			
A	1	Analyze effects on part configuration	Convert stated defects into part/assembly configuration change
A	2	Communicating with Buyers/Suppliers	Purchaser identification and contact practices, what information buyer can obtain, What to/what not to say, who to call, which buyer to go to
A	3	Discern affects on fit/form/function	How will part usage be affected by the disc.?
A	4	Ergonomic Lifting	Lift and hold up to 40# for 30s
A	5	Inspect Welds	Determine weld quality visually - relate stated defect into visual representation
A	6	Locate info in manuals/specs	Physically finding info in product catalogs or specifications that is useful to disposition or discrepancy review
A	7	Radius gage usage	Ability to properly use radius gages (verify stated fillet/radius size)
A	8	Read Lab Test Results	Knowledge and skill interpreting LTR results - who to ask when unclear
A	9	Review SCDs	Review of product reqm'ts
A	10	Use of precision measuring instruments	Using and reading micrometers, calipers, vernier devices, profilometer, scale, and other measuring devices
K	1	Anodize	Color and hard coat, how it is done, why, benefits, limitations, Specs. . .
K	2	Case Hardening	Purpose and applications for case hardening
K	3	Castings	Basics of casting (How it is done), mat'ls used, term definitions, the why of radiography, CSTI004 Casting Reqm'ts, CSPS064, Weld Repair
K	4	Chemfilm	Purpose and applications of chemfilm and magnesium protection, effects of acid entrapment, how to chemfilm, environmental concerns, CSFS027, 034
K	5	Cleaning mat'ls	Abrasive cleaning practices, mat'l applications, limitations, CSFS037, chemical cleaning applications (de-ox, alkaline, etch, pickle/passivate), effects of, effects on mat'ls, masking, CSFS035, 044, 045, CSTI002
K	6	CMM	Applications for CMM output, how to, how it works, basics of CMM
K	7	Cold Bonding	Applications of adhesives, RTV, "Loctites," effects on assembly, CSNP021, mat'l spec.
K	8	Composite laminates manufacturing	Types, classes, bagging techniques, tool cleaning techniques, causes of damage/deterioration, tool storage/handling, effects on final product, shop practices, trimming, CSAC001-008
K	9	Composite tooling prep	General knowledge of tool cleaning techniques, causes of damage/deterioration, tool storage/handling
K	10	Cure cycle	Oven and autoclave cure cycles for adhesives, impregnated fabrics, allowances for secondary cures, oven/autoclave data and meanings, general knowledge of thermosetting mat'ls
K	11	Dissimilar Mat'ls & Galvanic Action	Which finishes prevent corrosion, which finish fight corrosion, and how? CSFS031, Dissimilar Metals, Galvanic action
K	12	Engineering Drawing practices/stds	Drafting Room Manual, drafting practices and stds, CATIA file structure, graphics usage
K	13	Extrusion Procurement Reqm'ts	QPL reqm'ts for ext, CSTI036, agreement with Quality Dept., QAM issues, Special Processes per M&P or Quality Dept.
K	14	Fasteners (permanent)	Driven rivets, blind rivets/bolts, Hi-Loks, NAS-lockbolts, dimples, countersinks, CSMP028, 051, 052, 053
K	15	Fasteners (removable)	Thread stds, bolts, screws, threaded inserts, nuts, washers. How to use and install, effects of torque on strength (shear/tensile), locking reqm'ts.
K	16	Finish Codes	CSFS001, A/C Finish Codes
K	17	Forging	Basics of forging (how it is done), mat'ls used, nomenclature, jargon definitions; CMMP027, 028, CSTI023, 025, 034
K	18	Forming Practices	Sheet metal forming practices, applications, brake press, hydro-form, stretch, hammer, effects on mat'ls, work hardening, mat'l conditioning, CSMP017
K	19	Heat treatments	Aluminum alloys, steels, alloys, tempering, hardness, ductility, conductivity CSMP003, 004, 028, 047, CSPS026, 027
K	20	Hydrogen Embrittlement	Effects of electro-depositing on high-strength alloys, chemical baths, long term effects on fatigue life, CSMP004, Heat treat
K	21	Laminate loading	Composite load carrying characteristics, tailored stiffness/strength, effects at holes and openings, purpose of core, structural characteristics

(Exhibit D.2 continued)

Knowledge (K), Skill (S), or Ability (A)	Index	Name	Explanation of K, S, or A
K	22	Laminate Mat'ls	Glass/carbon/aramid woven fabrics, resin systems (epoxy, phenolic, polyester), available dry cloths, adhesives, handling reqm'ts, uses in lay-up, mat'l substitutions, core uses and types, applications of potting/Rohcell/foaming adhesive/syncore, effects o
K	23	Laminate rework	General practices for rework/repair of laminates, CSNP011, 012, CMMP021
K	24	Lubricant coats	Anodizing, hard coats, dry film lube, Karon, zinc phosphate, CSFS070
K	25	Machine shop practices	Applications of machining and typical Cessna shop practices
K	26	Machining practices	Physics of machining, honing, grinding, drilling. Applications of cutters. CSMP024 reqm'ts
K	27	Masking for etch	CSTI002 Masking for etch
K	28	Mat'l Cutting	Uses & reqm'ts of mechanical cutting, waterjet, lasercut, removal of recast (profiling), CSMP003, 049
K	29	Mat'l Damage Removal	Shop practice for mat'l removal, abrasive cleaning, "ding" blending
K	30	Mat'l Substitution	Mat'l substitutes as defined in CSRS020, evaluating substitutions, Special Processes
K	31	Metals behavior	Metals applications, mat'l properties, special considerations for high-strength metals, special treatments, changes in DADT, special considerations for heat resistance, when to anneal/normalize/temper
K	32	Metals properties	Mat'l mechanical properties, uses of properties, how properties are obtained, relationships among mat'ls of same family
K	33	NDI Processes	Uses and applications of UT, eddy current, MPI, LPI, C-scan, A-scan, RT, CSTI002, 003, …
K	34	Part or assy fit/form/function	Determining damage effects on part usage, purpose, integrity, and quality (general a/c part knowledge)
K	35	Peening	Purpose and applications of shotpeen, peen forming, how it is performed, mat'l effects/DADT/crack initiation/growth suppression, shot characteristics, substitutions, shop practices, CSMP027, 045
K	36	Plastic Welding	Applications of plastic welding, mat'ls used, how to
K	37	Plating/electro-depositing	Uses and applications of Cadmium, Brush Cadplate, TI-Cad, Chrome, Decorative Chrome, Nickel, Electroless Nickel, effects on high-strength alloys, corrosion protection, CSFS024, 026, 028, 022, 029, QQA-416, CMSP004, ASTM B571 (testing), MIL-C-26074, MIL-St
K	38	Primer	Uses and applications of epoxy primer, zinc chromate primer, powder coat primer, bond primer, primer surfacer, & others. How they work and appropriate uses. CMFS029, CSFS002, 003, 007, 018, 084, CSNP038.
K	39	REX-grain	The affects of recrystalized grain on material properties, DADT, etc.
K	40	Sealers	Applications and purposes of sealers, benefits, rework reqm'ts, shop practices, substitutes, CMMP021, CSNP035
K	41	Sheet mat'l procurement Reqm'ts	QPL reqm'ts for sheets, CMMP025, agreement with Quality Dept., QAM issues, Special Processes per M&P or Quality Dept.
K	42	Sheet mat'l quality	Sheet metal procurement quality reqm'ts (orange peel, ludering, gouges, …), CMMP019
K	43	Shop practices	General shop operating knowledge (i.e. what each machine does, how it does it, operator-machine interaction, safety concerns, . . .)
K	44	Staking Operations	Why staking is used to retain parts, effects on mat'l, change in crack initiation, how to stake correctly, NAS0331, Bearing Staking, CSMP023, Staking Bearings
K	45	Thermosetting	Basic knowledge of thermosetting mat'l behavior, machine usage, trimming, CSNP001, 006 Thermosetting Laminates
K	46	Topcoats (Finishes)	Uses and purpose of urethane, acrylic enamel, lacquer, baked, epoxy, vinyl, nylon powder, polyester, topcoats, preventative compounds CSFS006, 007, 018, 021, 075, 084, CSNP038
K	47	Transparency Inspection	Familiarity with allowable defects, optics definitions, use of the grid system, CSTI013
K	48	Vendor Codes	RMPN relationship to vendor supplied items, dataBase conversion in PIOS
K	49	Weld processes	Fusion welding, orbital welds, spot welding, brazing, mat'l cleaning, shielding, CSMP009, Brazing, CSMP039 Welding
K	50	Weld symbols	Knowledge of AWS A2.4, Weld Symbols, proper drafting technique
S	1	Determine damage cause	Use of visual clues to discern cause of damage and/or approximate location in process where damage occurred
S	2	Determine weld joint type	Visually determine type of weld joint from review of part
S	3	Determining load path	Visual understanding of part installation load path and purpose of part
S	4	Differentiate among mat'ls	Visually and mechanically identify mat'l family without outside input
S	5	General math	Use of shop math for dimensional analysis
S	6	ID approximate surface roughness	Skill in comparing visible surface roughness to eng dwg reqm'ts or profilometer reading estimate
S	7	ID good v bad mat'l edge	Deburr dimensions, machine practices, ID roughness, as procured from mill, cut edge, sanded, sheared, filed

(Exhibit D.2 continued)

Knowledge (K), Skill (S), or Ability (A)	Index	Name	Explanation of K, S, or A
S	8	ID REX-grain	Visually ID discern REX-grain from other surface defects and location on part
S	9	ID visible mat'l defect	ID orange peel, ludering, discoloration, corrosion
S	10	Interpret casting dwgs	B/P reading for casting characteristics, nomenclature, interpret part reqm'ts
S	11	Interpret eng dwg	B/P reading, drafting technique, sectioning, etc., What does the dwg say vs. what is intended.
S	12	Interpret forging dwgs	B/P reading for forging characteristics, nomenclature, interpret part reqm'ts
S	13	OPSS Reading	Understanding planning practices, data layout, reading routers, How-to-get info from this source.
S	14	Read oven/autoclave data	Reading data from raw cycle data/chart and understand effects on mat'ls - could be heat treat, laminate cure, plastics
S	15	Reading PowerView output	Understanding limitations of PowerView output relative to optics and subjective criteria
Future KSAs			
A	101	Interpret test results	Stress and fatigue test results review and applications to current work.
A	102	Locate appropriate info in reports	Navigation of loads/stress/test/fatigue reports. Familiarity with the structures reports is essential, especially on the newer airplanes. Detailed analysis of the structure is available to point analysis the right direction for criticality - Is this are
A	103	Use of analysis texts	Able to obtain appropriate resources from typically used Cessna texts (Bruhn, Niu, …) to facilitate analysis and understand theory behind analysis
K	101	Analysis Tools	What tools to use and when they are applicable.
K	102	Cold Expansion Process	CSMP026, Cold Work and appropriate uses. Available FTI tools data. Benefits of cold and physics of performing the process.
K	103	Crack Initiation Characteristics	Physics of crack initiation and crack growth theory.
K	104	FAR Requirements	14 CFR Part 23 and 25 Loads, Performance, and Structural reqm'ts. Some knowledge of major manufacturing reqm'ts (Part 21) and/or operating reqm'ts.
K	105	Fatigue critical locations by model	Specific knowledge by aircraft model of areas with low MS and/or known cyclic failures, areas with risk for sonic fatigue, parts with limited service lifes, inspection intervals, inspection techniques by phase or location. MM Ch. 4 (AWL).
K	106	Fatigue basics	Knowledge of general fatigue information such as normal design values for edge distance, spacing, fastener stiffness selection, material stiffness values, effects of reduced e.d./spacing/thinout, stiffness effects of straps/gussets/oversizing, bypass, bea
K	107	FEM Principles	General knowledge of elemental properties, generic modeling techniques, load schemes, applications for finite element modeling, understanding of model fineness.
K	108	Margin of safety	Familiarity with MS computations and equations to combine stresses of different types.
K	109	Mechanics of materials	Materials behavior, general material properties and characteristics, general "strength" values and ranking among different materials used at Cessna.
K	110	MMPDS (Mil-Hdbk-5G)	Knowledge of information contained in and uses of.
K	111	Physics of aircraft	Knowledge of typical Cessna aircraft loads (down load on tail, wing bending theory, side loads due to yaw, fuselage pressure loads…). In depth understanding of statics and dynamics and relationship to loads applied to parts. Knowledge of part purpose (w
K	112	Stress basics	Basic load path understanding, minimum typical spacing allowable, edge distance rules, typical loading in part types (axial members, shear webs, bending stiffeners), …
S	101	Basic stress analysis	Applications of bending, shear, torsion, pressure, tension/compression, and bearing computations. Joint strength analysis; typical equivalent strength techniques.
S	102	Fatigue software	Able to use Cracks95/AFGROW/EditCracks95 (etc) to compute change in fatigue characteristics of a part configuration. Program navigation and results interpretation. Compute change in fastener stiffness. (*Not full DADT skills, I.e. spectrum development, L
S	103	FEM	Applications of FEM, choosing proper elements, mesh control, loads application, and running analysis. Interpretting model output and converting into usable formats.
S	104	Kt Values	Determining Kt values, understanding of why Kt's are a result of geometry, meaning of Kt analysis.
S	105	Stress software	Use of properties and geometry software, buckling/crippling software, web analysis, fastener patterns, …

EXHIBIT D.3. CONDENSED KSA COLLECTION FOR CMF EPS

Task			
Major Category of Nonconformance			
Process/NC Component			
	Knowledge of	Skill in	Ability to
PRODUCTION SUPPORT ENGINEER			
Answer Nonconformance			
Develop Disposition			
Assembly			
Corrosion protection	Dissimilar Mat'ls & Galvanic Action	Interpret eng dwg	Locate info in manuals/specs
	Finish Codes	Differentiate among mat'ls	
	Cleaning mat'ls		
	Chemfilm		
	Anodize		
Finishes	Dissimilar Mat'ls & Galvanic Action	General math	Locate info in manuals/specs
	Finish Codes	Differentiate among mat'ls	
	Primer		
	Topcoats (Finishes)		
	Hydrogen Embrittlement		
	CSNP035, Sealers		
	Cleaning mat'ls		
Cold bond	Cold Bonding	Differentiate among mat'ls	Locate info in manuals/specs
	Part or assy fit/form/function		
	Cleaning mat'ls		
Damaged fasteners	Fasteners (permanent)	Determining load path	Locate info in manuals/specs
	Fasteners (removable)	Determine damage cause	
	Sealers		
	Shop practices		
	Mat'l Substitution		
Mat'l damage	Mat'l Damage Removal	Determine damage cause	Discern affects on fit/form/function
	Chemfilm	Differentiate among mat'ls	
	Part or assy fit/form/function	General math	
	Mat'l Cutting	ID good v bad mat'l edge	
Poor dwg callout	Engineering Drawing practices/stds	Interpret eng dwg	
Missing parts	Part or assy fit/form/function	Interpret eng dwg	
Missed ops	Shop practices	Interpret eng dwg	
		OPSS Reading	
Incorrect supplier parts	Vendor Codes		Analyze effects on part configuration
			Review SCDs
			Communicating with Buyers/Suppliers
Bearing Staking	Staking Operations		
	Metals behavior		
Composites			
Cocure/Secondary bond	Cure cycle		Locate info in manuals/specs
	Laminate Mat'ls		Use of precision measuring instruments
	Shop practices		
	Laminate loading		
	Thermosetting		
	Composite laminates manufacturing		
Layup	Composite laminates manufacturing	Interpret eng dwg	Locate info in manuals/specs
	Composite tooling prep		
	Laminate Mat'ls		
Core/potting	Laminate Mat'ls		Locate info in manuals/specs
	Composite laminates manufacturing		
	Shop practices		
	Thermosetting		
Bagging	Composite laminates manufacturing		Locate info in manuals/specs
Cure cycle	Cure cycle	Read oven/autoclave data	Locate info in manuals/specs
	Composite laminates manufacturing		
Cold bond	Cold Bonding		Locate info in manuals/specs
	Cure cycle		
Fit issues	Composite laminates manufacturing		
	Machine shop practices		
Handling damage	Laminate rework	Determine damage cause	
	Laminate Mat'ls	Differentiate among mat'ls	
	Laminate loading	ID good v bad mat'l edge	
Mat'l NC	Laminate Mat'ls	Differentiate among mat'ls	Read Lab Test Results
(weave, resin contents, ou	Part or assy fit/form/function	ID visible mat'l defect	
	Laminate loading		
Finishes			
General	Dissimilar Mat'ls & Galvanic Action	Differentiate among mat'ls	
	Lubricant coats		
	Topcoats (Finishes)		

(Exhibit D.3 continued)

	Knowledge of	Skill in	Ability to
Cadmium plate	Plating/electro-depositing		Locate info in manuals/specs
	Hydrogen Embrittlement		
	Heat treatments		
Shotpeen	Peening		Locate info in manuals/specs
	Shop practices		
Prime (epoxy/zinc)	CSFS001, A/C Finish Codes		Locate info in manuals/specs
	Primer		
	Shop practices		
Anodizing	Chemfilm (AL and Mg)		Locate info in manuals/specs
	Anodize		
Chrome/Nickel Plate	Plating/electro-depositing		Locate info in manuals/specs
	Hydrogen Embrittlement		
	Heat treatments		
Heat treat	Heat treatments	Differentiate among mat'ls	Locate info in manuals/specs
	Metals properties	Read oven/autoclave data	
	Hydrogen Embrittlement		
	Case Hardening		
Abrasive Cleaning	Cleaning mat'ls		
	Mat'l Damage Removal		
Chemical Cleaning	Cleaning mat'ls		Locate info in manuals/specs
	Heat treatments		
	Hydrogen Embrittlement		
	Masking for etch		
Powder Coat	Primer		
	Powder coat applications		
	Shop practices		
Formed Parts			
Brake/Hydroforming	Forming Practices	ID visible mat'l defect	Radius gage usage
	Heat treatments		Discern affects on fit/form/function
	Metals behavior		
	Metals properties		
	Sheet mat'l quality		
	Mat'l Cutting		
Chem-mill	Masking for etch		
	Cleaning mat'ls		
Mat'l Profiling	Mat'l Cutting		Discern affects on fit/form/function
	Metals properties		
	Metals behavior		
Deburr	Mat'l Cutting	ID good v bad mat'l edge	
Stretch	Metals behavior	ID visible mat'l defect	
	Forming Practices		
	Sheet mat'l quality		
Wrong tool	Part or assy fit/form/function		Analyze effects on part configuration
CGNT/MDM Issues	Part or assy fit/form/function	Interpret eng dwg	Analyze effects on part configuration
	Forming Practices		
	Shop practices		
Machined Parts			
Deburr	Mat'l Cutting	ID good v bad mat'l edge	Ergonomic Lifting
Machining, hone, grind, (	Machine shop practices	Interpret eng dwg	Use of precision measuring instruments
	Machining practices	General math	Use of profilometer
	CMM	Interpret forging dwgs	Radius gage usage
	Machine applications		
	Metals behavior		
	Lubricant coats		
	Metals properties		
Damage-handling/corros	Mat'l Damage Removal	Determining load path	Analyze effects on part configuration
	Lubricant coats	Determine damage cause	
	Dissimilar Mat'ls & Galvanic Action		
	Cleaning mat'ls		
	Metals behavior		
Forging	Forging	Interpret forging dwgs	Ergonomic Lifting
	Part or assy fit/form/function	ID REX-grain	Communicating with Buyers/Suppliers
	REX-grain		Read Lab Test Results
	Vendor Codes		
Casting	Castings	Interpret casting dwgs	Communicating with Buyers/Suppliers
	Vendor Codes	ID approximate surface roughness	Read Lab Test Results
	Part or assy fit/form/function		
Dimensional	Part or assy fit/form/function	General math	Discern affects on fit/form/function
		Interpret eng dwg	

(Exhibit D.3 continued)

	Knowledge of	Skill in	Ability to
REX grain	Masking for etch	Reading Forging drawings	Ergonomic Lifting
	REX-grain	ID REX-grain	
	Metals behavior		
	Forging		
Plastics			
Optics distortion check	Transparency Inspection	Interpret eng dwg	Locate info in manuals/specs
		Reading PowerView output	Ergonomic Lifting
			Review SCDs
Thermoforming	Thermosetting		Locate info in manuals/specs
	Part fit/form/function		
	Plastic Welding		
Raw Mat'l			
Corrosion	Dissimilar Mat'ls & Galvanic Action	S/A in Assembly, Finishes	Discern affects on fit/form/function
	Mat'l Damage Removal		Read Lab Test Results
	Cleaning mat'ls		
nonQPL	Extrusion Procurement Reqm'ts		Locate info in manuals/specs
	Sheet mat'l procurement Reqm'ts		Communicating with Buyers/Suppliers
	Mat'l Substitution		
	Sheet mat'l quality		
No cert	Sheet mat'l procurement Reqm'ts	General math	Locate info in manuals/specs
No coupons	Sheet mat'l procurement Reqm'ts		Locate info in manuals/specs
	Heat treatments		
Alternate mat'ls	Metals behavior	General math	Discern affects on fit/form/function
	Mat'l Substitution		
	Sheet mat'l quality		
	Extrusion Procurement Reqm'ts		
Sealer	Sealers	Interpret lab test requests	Locate info in manuals/specs
			Read Lab Test Results
Welding			
Casting	Castings	Interpret casting dwgs	Communicating with Buyers/Suppliers
		ID approximate surface roughness	
Weld issue	Weld symbols	Determine weld joint type	Inspect Welds
	Metals behavior	Determining load path	Locate information in specs/manuals
	Weld processes		
	Cleaning mat'ls		
	Shop practices		
	Heat treatments		
	Hydrogen Embrittlement		
General			
	NDI Processes	Determining load path (included in Physics of A/C)	Read Lab Test Results
	Engineering Drawing practices/stds	General math	
	Finish Codes	Interpret eng dwg	
	Metals properties	OPSS Reading	
Future under nearly Autonomous operation			
Stress Review	Dissimilar Mat'ls & Galvanic Action	Basic stress analysis	Discern affects on fit/form/function
	Engineering Drawing practices/stds	Determining load path (included in Physics of A/C)	Interpret test results
	FAR Requirements	FEM	Locate appropriate info in reports
	Fatigue critical locations by model	Stress software	Locate info in manuals/specs
	FEM Principles		Use stress analysis texts
	Margin of safety		
	Mechanics of materials		
	Mil-Hdk-5x		
	NDI Processes		
	Part fit/form/function		
	Physics of aircraft		
	Shop practices		
	Stress rules of thumb		
Fatigue Analysis	Engineering Drawing practices/stds	Determining load path (included in Physics of A/C)	Discern affects on fit/form/function
	FAR Requirements	Fatigue software	Interpret test results
	Fatigue critical locations by model	Kt Values	Locate appropriate info in reports
	Fatigue rules of thumb		Locate info in manuals/specs
	Mechanics of materials		
	NDI Processes		
	Part fit/form/function		
	Physics of aircraft		
	Shop practices		

EXHIBIT D.4. SURVEY RESULTS – RATERS PERCEIVED CRITICALITY OF KSA TO DISPOSITION

Knowledge (K), Skill (S), or Ability (A)	Index	Name	Supvr	GL1	GL2	GL3	Eng1	Eng2	Eng3	Eng4	Eng5	Eng6	Eng7	Eng8	Eng9	Eng10	Eng11	Eng12	Eng13	Average C	C Rank Order (current)	C Rank Order (future)
Current KSAs																						
A	1	Analyze effects on part configuration	4	5	3	4	4	3	4	5	5	4	3	4	2	4	5	4	4	3.94	8	18
A	2	Communicating with Buyers/Suppliers	2	3	3	1	2	3	3	3	3	4	2		1		4			2.62	66	85
A	3	Discern affects on fit/form/function	4	5	5	4	4	4	5	5	5	5	5	4	4	5	5	4	4	4.53	1	4
A	4	Ergonomic Lifting	4	1	1	2	1	2	2	3	1	3	2	1	1	3	1	2	2	1.88	75	95
A	5	Inspect Welds	1	4	3		3	3	3	3	4	4	3	3	1	4	4			3.07	45	61
A	6	Locate info in manuals/specs	5	5	3	4	5	3	4	5	4	5	5		3	3	3	4	4	4.06	6	12
A	7	Radius gage usage	1	1	3	2	2	2	2	1	1	2	2	3	3	2	3			2.00	74	93
A	8	Read Lab Test Results	3	2	4	2	3	2	3	3	4	4	4		3	2	4	2	2	2.94	48	66
A	9	Review SCDs	3	3	1	4	2	3	2	1	4	3			1	2	4	4	4	2.73	61	80
A	10	Use of precision measuring instruments	3	4	5	3	2	2	3	2	2	5	5	4	5	3	4	3	3	3.41	27	39
K	1	Anodize	2	3	3	3	3	3	3	3	4	4	3		4	4	4	3	3	3.25	39	51
K	2	Case Hardening	2	2		2	3	3	3	3	4	4	3		3	2	4			2.92	50	68
K	3	Castings	3	3			3	3	3	3	4	4	3		3		4			3.27	36	48
K	4	Chemfilm	5	5	4	3	3	3	3	3	4	4	3		3	4	4			3.64	16	27
K	5	Cleaning mat'ls	4	5	4	3	4	3	2	3	4	4	3		2	4	4	2	2	3.31	32	44
K	6	CMM	1	2	2	3	2	3	2	2	3		2		3		4			2.42	71	90
K	7	Cold Bonding	3	4	4	2	3	3	3	3	3	4	3		3	4	4	2	2	3.13	43	59
K	8	Composite laminates manufacturing	5	5			4	3	3	3	3	4	3		1		5			3.55	20	31
K	9	Composite tooling prep	3	3			4	3	2	3	3	4	2		1		3			2.82	55	73
K	10	Cure cycle	4	4	3		4	3	3	3	4	4	2		2	2	5			3.31	34	46
K	11	Dissimilar Mat'ls & Galvanic Action	5	4	4	4	4	3	4	3	4	5	4		3	5	5	2	2	3.81	13	23
K	12	Engineering Drawing practices/stds	4	2	3	5	2	3	3	2	3	4	3	3	2	4	3	4	4	3.18	40	56
K	13	Extrusion Procurement Reqm'ts	3	3	2	1	3	3	2	2	4	4	3		1	2	5			2.71	62	81
K	14	Fasteners (permanent)	4	4	5		4	4	3	5	4	5	5	5	5	5	5			4.50	2	5
K	15	Fasteners (removable)	4	3	4	3	4	4	3	5	4	5	5	3	5	5	5	2	2	3.88	10	20
K	16	Finish Codes	5	4	5	4	4	3	2	5	4	4	4	3	5	3	4			3.93	9	19
K	17	Forging	4	2		3	3	3	3	3	4	4	3		1		4	3	3	3.07	45	61
K	18	Forming Practices	3	2	4		4	3	2	3	4	4	5	2	3	4	4			3.36	29	41
K	19	Heat treatments	4	5	4	3	5	4	3	3	4	4	4	2	3	4	5	2	2	3.59	18	29
K	20	Hydrogen Embrittlement	3	5		3	5	3	4	3	4	4	4		1		5			3.67	15	26
K	21	Laminate loading	2	5			4	4	3	3	4	4	3		1		3			3.27	36	48
K	22	Laminate Mat'ls	3	3			4	3	4	3	4	4	3		1		4			3.27	36	48
K	23	Laminate rework	5	4			4	3	4	3	4	4	4		1		5			3.73	14	25
K	24	Lubricant coats	2	3	3	3	3	3	2	3	4	4	3		2	2	3	2	2	2.75	60	78
K	25	Machine shop practices	3	4	4	4	3	3	4	3	4	4	4		1	2	4	3	3	3.31	32	44
K	26	Machining practices	4	4	4	3	3	2	3	3	4	4	3		1	3	3			3.14	41	57
K	27	Masking for etch	3	4	3	2	3	2	1	3	4	4	3		1	3	3			2.79	58	76
K	28	Mat'l Cutting	3	2	4	3	3	3	2	3	3	4	3		1	4	3			2.93	49	67
K	29	Mat'l Damage Removal	3	2	4	3	3	3	3	3	4	4	5	5	1	4	4	3	3	3.35	31	43
K	30	Mat'l Substitution	4	3	4	3	4	3	4	2	4	4	4	3	2	4	5	3	3	3.47	24	36
K	31	Metals behavior	5	5	2	2	5	3	4	4	4	4	3	3	3	4	5	2	2	3.53	23	34
K	32	Metals properties	3	5	2	3	4	3	2	4	4	4	5	3	3	3	4	2	2	3.29	35	47
K	33	NDI Processes	4	5	3	2	4	3	3	3	4	4	4	4	3	3	4			3.53	22	33
K	34	Part or assy fit/form/function	4	5	5	4	4	4	4	5	4	5	5	5	4	5	5	4	4	4.47	3	8
K	35	Peening	2	3		2	3	3	2	3	4	4	3		1		4	2	2	2.71	62	81

(Exhibit D.4 continued)

Knowledge (K), Skill (S), or Ability (A)	Index	Name	Supvr	GL1	GL2	GL3	Eng1	Eng2	Eng3	Eng4	Eng5	Eng6	Eng7	Eng8	Eng9	Eng10	Eng11	Eng12	Eng13	Average C	C Rank Order (current)	C Rank Order (future)
K	36	Plastic Welding	1	1			2	2	3	1	4	3	3		1	3	3			2.25	73	92
K	37	Plating/electro-depositing	5	4		2	5	4	4	3	4	4	3		1		4	2	2	3.36	29	41
K	38	Primer	4	3	4		4	3	3	3	4	4	4	3	4	4	3			3.57	19	30
K	39	REX-grain	2	4			4	4	3	3	4	4	4		1		5			3.45	25	37
K	40	Sealers	3	3	3	2	3	3	2	2	4	4	4	3	3	3	3	2	2	2.88	52	70
K	41	Sheet mat'l procurement	4	2	3		2	4	2	2	4	2	3		1	2	3			2.62	66	85
K	42	Sheet mat'l quality	3	3	3		3	3	2	2	4	4	3		1	4	3			2.92	50	68
K	43	Shop practices	3	4	3	3	3	4	2	3	3	3	4	3	3	3	3			3.13	42	58
K	44	Staking Operations	2	3		3	3	2	2	3	4	4	4		1		3	3	3	2.86	53	71
K	45	Thermosetting	2				3	2	3	3	4	4	2		1		3			2.70	65	84
K	46	Topcoats (Finishes)	2	3	1	2	2	2	2	3	4	4	3		1	2	4			2.50	69	88
K	47	Transparency Inspection	3	3			3	2	3	3	4	4	3		1		2			2.82	55	73
K	48	Vendor Codes	1		3		2	2	2	3	3	3			1	2	3			2.27	72	91
K	49	Weld processes	4	4	2		4	3	3	3	4	4	4		1	1	3			3.08	44	60
K	50	Weld symbols	4	2	3		3	2	4	3	4	4	4	1	2	1	3			2.86	53	71
S	1	Determine damage cause	3	3	4	5	3	4	4	5	4	4	4	4	3	4	4	4	4	3.88	10	20
S	2	Determine weld joint type	3	2	3		3	2	3	3	3	4	4	2	1	1	5			2.79	58	76
S	3	Determining load path	4	4	5		4	3	4	5	4	5	4	4	4	5	5			4.29	5	10
S	4	Differentiate among mat'ls	1	3	3		3	3	2	5	3	4	5	3	2	1	4			3.00	47	63
S	5	General math	5	4	5	4	2	4	3	5	4	5	4	3	3	5	4	4	4	4.00	7	13
S	6	ID approximate surface	1	1	3	3	2	2	2	3	3	4	3		1	2	4			2.43	70	89
S	7	ID good v bad mat'l edge	1	3	3	3	3	2	3	3	3	4	3		1	2	4			2.71	62	81
S	8	ID REX-grain	3	4			4	3	4	3	3	4	4		1		5			3.45	25	37
S	9	ID visible mat'l defect	3	3	3	4	3	3	3	3	3	4	4		1	4	5	4	4	3.38	28	40
S	10	Interpret casting dwgs	3	3			4	3	4	3	4	5	5		1		5			3.64	17	28
S	11	Interpret eng dwg	5	5	5	4	4	3	4	5	4	5	5	4	5	5	4	4	4	4.41	4	9
S	12	Interpret forging dwgs	3	3			4	3	4	3	4	5	5		1		4			3.55	20	31
S	13	OPSS Reading	4	5	4	3	3	3	4	5	3	5	5	3	4	5	4	3	3	3.88	10	20
S	14	Read oven/autoclave	2	2	3		3	2	3	3	3	4	4		1	1	3			2.62	66	85
S	15	Reading PowerView	3	3			3	2	3	3	3	4			1		3			2.80	57	75
Future KSAs																						
A	101	Interpret test results	3	4							4						3			3.50		35
A	102	Locate appropriate info in reports	4	4							4						3			3.75		24
A	103	Use of analysis texts	2	4							2						4			3.00		63
K	101	Analysis Tools	3	4							5						4			4.00		13
K	102	Cold Expansion Process	4	4							4						4			4.00		13
K	103	Crack Initiation Characteristics	4	4							4						4			4.00		13
K	104	FAR Requirements	4	3							4						2			3.25		51
K	105	Fatigue critical locations by model	5	4							4						5			4.50		5
K	106	Fatigue basics	5	5							4						5			4.75		1
K	107	FEM Principles	3	2							3						3			2.75		78
K	108	Margin of safety	2	4							4						3			3.25		51
K	109	Mechanics of materials	5	5							4						5			4.75		1
K	110	MMPDS (Mil-Hdbk-5G)	5	4							3						4			4.00		13
K	111	Physics of aircraft	5	5							5						4			4.75		1
K	112	Stress basics	4	5							4						5			4.50		5
S	101	Basic stress analysis	5	4							4						4			4.25		11
S	102	Fatigue software	5	3							3						1			3.00		63
S	103	FEM	2	2							2						2			2.00		93
S	104	Kt Values	3	4							3						3			3.25		51
S	105	Stress software	4	3							3						3			3.25		51

EXHIBIT D.5. SURVEY RESULTS – RATERS PERCEIVED FREQUENCY OF KSA USE

Knowledge (K), Skill (S), or Ability (A)	Index	Name	Supvr	GL1	GL2	GL3	Eng1	Eng2	Eng3	Eng4	Eng5	Eng6	Eng7	Eng8	Eng9	Eng10	Eng11	Eng12	Eng13	Average F	F Rank Order (current)	F Rank Order (future)
Current KSAs																						
A	1	Analyze effects on part configuration	5	5	1	4	4	4	4	5	4	4	2	2	2	4	5	3	3	3.59	10	16
A	2	Communicating with Buyers/Suppliers	2	3	1	2	2	2	3	2	2	1	1		1		3			1.92	68	84
A	3	Discern affects on fit/form/function	4	5	3	3	5	3	5	5	5	5	3	3	4	4	5	3	3	4.00	5	8
A	4	Ergonomic Lifting	3	2	1	3	1	1	2	2	1	3	1	1	1	2	1	2	2	1.71	73	91
A	5	Inspect Welds	1	4	1		4	2	3	3	3	3	2	2	1	1	4			2.43	48	59
A	6	Locate info in manuals/specs	4	5	2	4	5	3	4	5	5	5	4		2	3	3	3	3	3.75	9	13
A	7	Radius gage usage	1	1	1	1	1	2	1	1	1	1	1	1	1	1	2			1.13	75	95
A	8	Read Lab Test Results	3	2	3	2	3	2	3	3	3	4	3		1	3	3	2	2	2.63	37	48
A	9	Review SCDs	1	2	1	3	2	3	1	1	4	1			1	1	2	3	3	1.93	67	83
A	10	Use of precision measuring instruments	2	3	5	4	3	2	3	2	2	5	5	5	5	3	3	3	3	3.41	11	18
K	1	Anodize	2	3	1	3	3	2	3	3	4	3	2		1	4	4	2	2	2.63	37	48
K	2	Case Hardening	1	1		1	2	2	3	3	4	2	1		1	1	4			2.00	63	75
K	3	Castings	3	2			3	2	3	3	4	2	1		1		3			2.45	44	55
K	4	Chemfilm	4	4	2	3	2	2	3	3	4	3	2		1	2	3			2.71	32	43
K	5	Cleaning mat'ls	4	4	2	3	3	2	2	3	4	3	2		1	2	3	2	2	2.63	37	48
K	6	CMM	1	2	1	2	2	2	1	2	2		1		1		2			1.58	74	92
K	7	Cold Bonding	3	3	3	2	2	2	3	3	3	3	2		1	3	2	2	2	2.44	47	58
K	8	Composite laminates manufacturing	5	3			4	3	3	3	2	4	2		1		4			3.09	17	25
K	9	Composite tooling prep	2	1			4	3	2	3	2	2	1		1		2			2.09	61	73
K	10	Cure cycle	3	2	1		4	3	4	3	4	4	1		1	1	3			2.62	41	52
K	11	Dissimilar Mat'ls & Galvanic Action	4	4	2	3	3	2	4	3	4	4	2		1	5	4	2	2	3.06	19	27
K	12	Engineering Drawing practices/stds	5	2	2	4	1	4	3	2	3	2	3	3	1	4	3	3	3	2.82	28	37
K	13	Extrusion Procurement Reqm'ts	2	3	1	1	2	2	2	2	5	3	1		1	1	3			2.07	62	74
K	14	Fasteners (permanent)	3	4	5		4	3	4	5	5	4	5	5	5	5	3			4.29	2	4
K	15	Fasteners (removable)	3	3	3	4	4	2	4	5	5	4	3	2	5	4	3	2	2	3.41	11	18
K	16	Finish Codes	5	5	5	3	4	2	4	5	5	4	4	4	5	3	3			4.07	4	7
K	17	Forging	3	3		3	2	2	3	3	5	3	1		1		3	3	3	2.71	32	43
K	18	Forming Practices	4	3	4		3	2	2	3	5	3	4	2	1	3	3			3.00	21	29
K	19	Heat treatments	4	5	2	2	4	2	4	3	5	4	3	2	2	3	4	2	2	3.12	16	24
K	20	Hydrogen Embrittlement	4	3		2	4	3	4	3	5	3	1		1		3			3.00	21	29
K	21	Laminate loading	2	1			4	2	3	3	5	4	1		1		3			2.64	35	46
K	22	Laminate Mat'ls	4	1			4	2	3	3	5	4	1		1		3			2.82	30	39
K	23	Laminate rework	5	1			4	2	3	3	5	4	1		1		4			3.00	21	29
K	24	Lubricant coats	2	3	2	2	2	2	2	3	5	3	1		2	1	3	2	2	2.31	54	65
K	25	Machine shop practices	3	3	2	4	3	2	4	3	5	3	2		1	2	4	3	3	2.94	24	33
K	26	Machining practices	3	3	2	3	3	2	2	3	5	3	3		1	2	3			2.71	32	43
K	27	Masking for etch	3	3	1	1	3	2	1	3	5	3	1		1	1	3			2.21	57	69
K	28	Mat'l Cutting	2	2	4	3	2	2	1	3	3	3	1		1	2	3			2.29	55	66
K	29	Mat'l Damage Removal	3	4	4	5	3	2	4	3	5	3	4	4	1	4	3	3	3	3.41	11	18
K	30	Mat'l Substitution	4	3	2	3	2	3	4	2	5	3	2	2	2	4	3	2	2	2.82	28	37
K	31	Metals behavior	5	5	1	3	4	3	4	4	5	3	2	2	1	4	2	2	2	3.06	20	28
K	32	Metals properties	3	5	2	3	3	3	3	4	5	3	3	1	1	4	2	2	2	2.88	25	34
K	33	NDI Processes	4	5	2	3	3	2	3	4	5	4	2	3	2	1	3			3.07	18	26
K	34	Part or assy fit/form/function	5	5	5	4	4	3	5	5	5	5	4	4	3	5	4	3	3	4.24	3	6
K	35	Peening	2	2		2	2	2	2	3	5	3	1		1		2	2	2	2.21	57	69

(Exhibit D.5 continued)

Knowledge (K), Skill (S), or Ability (A)	Index	Name	Supvr	GL1	GL2	GL3	Eng1	Eng2	Eng3	Eng4	Eng5	Eng6	Eng7	Eng8	Eng9	Eng10	Eng11	Eng12	Eng13	Average F	C Rank Order (current)	C Rank Order (future)
K	36	Plastic Welding	1	1			1	2	2	1	5	1	1		1	3	2			1.75	72	88
K	37	Plating/electro-depositing	3	4		2	4	3	4	3	5	3	1		1		3	2	2	2.86	26	35
K	38	Primer	3	5	2		3	3	3	3	5	4	2	1	3	3	4			3.14	15	23
K	39	REX-grain	3	3			3	2	4	3	5	3	1		1		2			2.73	31	42
K	40	Sealers	2	3	2	2	2	2	2	2	5	4	3	2	2	2	2	2	2	2.41	51	62
K	41	Sheet mat'l procurement	2	2	1		2	3	2	2	5	1	1		1	1	3			2.00	63	75
K	42	Sheet mat'l quality	1	2	1		2	2	2	2	5	3	1		1	1	3			2.00	63	75
K	43	Shop practices	3	4	1	3	2	3	2	2	3	2	2	2	1	1	2			2.20	59	71
K	44	Staking Operations	2	3		2	2	2	3	3	5	3	1		1		2	3	3	2.50	42	53
K	45	Thermosetting	2				3	2	3	3	5	3	1		1		2			2.50	42	53
K	46	Topcoats (Finishes)	2	2	1	2	2	2	2	3	5	3	2		1	1	2			2.14	60	72
K	47	Transparency Inspection	3	3			2	2	3	3	5	2	1		1		2			2.45	44	55
K	48	Vendor Codes	2		1		1	2	2	3	2	2			1	2	3			1.91	69	85
K	49	Weld processes	4	5	1		4	2	3	3	5	3	1		1	2	3			2.85	27	36
K	50	Weld symbols	4	2	1		3	2	3	3	5	3	2	1	1	1	3			2.43	48	59
S	1	Determine damage cause	3	3	4	4	3	3	4	5	5	3	3	3	2	3	3	2	2	3.24	14	22
S	2	Determine weld joint type	4	3	1		2	2	4	3	3	3	2	1	1	1	4			2.43	48	59
S	3	Determining load path	4	3	4		3	3	4	5	5	4	4	3	3	5	3			3.79	7	11
S	4	Differentiate among mat'ls	2	3	1		2	2	3	5	3	3	4	1	1	1	2			2.36	53	64
S	5	General math	5	4	3	4	3	3	5	5	5	5	2	3	3	4	3	4	4	3.82	6	10
S	6	ID approximate surface	1	1	2	3	2	2	2	3	3	3	1		1	1	3			2.00	63	75
S	7	ID good v bad mat'l edge	1	3	2	3	3	2	3	3	3	3	1		1	1	3			2.29	55	66
S	8	ID REX-grain	3	3			3	2	4	3	3	3	1		1		3			2.64	35	46
S	9	ID visible mat'l defect	4	2	2	3	3	2	2	3	3	3	2		1	3	3	3	3	2.63	37	48
S	10	Interpret casting dwgs	3	1			2	2	3	3	5	2	1		1		3			2.36	52	63
S	11	Interpret eng dwg	5	5	4	4	5	3	5	5	5	5	4	4	4	5	3	4	4	4.35	1	3
S	12	Interpret forging dwgs	3	1			2	3	3	3	5	3	1		1		2			2.45	44	55
S	13	OPSS Reading	4	5	4	3	4	3	4	5	2	5	4	2	3	5	3	4	4	3.76	8	12
S	14	Read oven/autoclave	2	1	2		2	2	3	2	2	3	1		1	1	2			1.85	70	86
S	15	Reading PowerView	2	2			1	2	2	2	2	3			1		1			1.80	71	87
Future KSAs																						
A	101	Interpret test results	2	2							2						2			2.00		75
A	102	Locate appropriate info in reports	4	3							2						2			2.75		40
A	103	Use of analysis texts	2	1							1						2			1.50		93
K	101	Analysis Tools	5	2							5						3			3.75		13
K	102	Cold Expansion Process	1	3							1						2			1.75		88
K	103	Crack Initiation Characteristics	3	3							1						2			2.25		68
K	104	FAR Requirements	5	3							1						2			2.75		40
K	105	Fatigue critical locations by model	4	3							3						2			3.00		29
K	106	Fatigue basics	5	4							3						4			4.00		8
K	107	FEM Principles	1	2							1						3			1.75		88
K	108	Margin of safety	4	4							2						3			3.25		21
K	109	Mechanics of materials	5	5							4						4			4.50		2
K	110	MMPDS (Mil-Hdbk-5G)	4	3							2						5			3.50		17
K	111	Physics of aircraft	5	5							5						4			4.75		1
K	112	Stress basics	5	4							3						5			4.25		5
S	101	Basic stress analysis	5	3							2						5			3.75		13
S	102	Fatigue software	4	2							1						1			2.00		75
S	103	FEM	2	2							1						1			1.50		93
S	104	Kt Values	3	3							1						1			2.00		75
S	105	Stress software	4	2							1						1			2.00		75

EXHIBIT D.6. SURVEY RESULTS – RATERS PERCEIVED IMPORTANCE OF KSA(C*F)

Knowledge (K), Skill (S), or Ability (A)	Index	Name	Supvr	GL1	GL2	GL3	Eng1	Eng2	Eng3	Eng4	Eng5	Eng6	Eng7	Eng8	Eng9	Eng10	Eng11	Eng12	Eng13	Importance (Average C*F)	F Rank Order (current)	F Rank Order (future)
Current KSAs																						
A	1	Analyze effects on part configuration	20	25	3	16	16	12	16	25	20	16	6	8	4	16	25	12	12	14.82	10	16
A	2	Communicating with Buyers/Suppliers	4	9	3	2	4	6	9	6	6	4	2		1		12			5.23	69	86
A	3	Discern affects on fit/form/function	16	25	15	12	20	12	25	25	25	25	15	12	16	20	25	12	12	18.75	4	8
A	4	Ergonomic Lifting	12	2	1	6	1	2	4	6	1	9	2	1	1	6	1	4	4	3.69	74	93
A	5	Inspect Welds	1	16	3		12	6	9	9	12	12	6	6	1	4	16			8.07	45	57
A	6	Locate info in manuals/specs	20	25	6	16	25	9	16	25	20	25	20		6	9	9	12	12	16.20	7	12
A	7	Radius gage usage	1	1	3	2	2	4	2	1	1	2	2	3	3	2	6			2.33	75	95
A	8	Read Lab Test Results	9	4	12	4	9	4	9	9	12	16	12		3	6	12	4	4	8.33	43	55
A	9	Review SCDs	3	6	1	12	4	9	2	1	16	3			1	2	8	12	12	5.71	66	83
A	10	Use of precision measuring instruments	6	12	25	12	6	4	9	4	4	25	25	20	25	9	12	9	9	12.94	14	22
K	1	Anodize	4	9	3	9	9	6	9	9	16	12	6		4	16	16	6	6	8.93	40	52
K	2	Case Hardening	2	2		2	6	6	9	9	16	8	3		3	2	16			6.46	61	78
K	3	Castings	9	6			9	6	9	9	16	8	3		3		12			8.18	44	56
K	4	Chemfilm	20	20	8	9	6	6	9	9	16	12	6		3	8	12			10.29	28	37
K	5	Cleaning mat'ls	16	20	8	9	12	6	4	9	16	12	6		2	8	12	4	4	9.60	32	42
K	6	CMM	1	4	2	6	4	6	2	4	6		2		3	0	8			3.69	73	92
K	7	Cold Bonding	9	12	12	4	6	6	9	9	9	12	6		3	12	8	4	4	8.07	46	58
K	8	Composite laminates manufacturing	25	15			16	9	9	9	6	16	6		1		20			12.00	19	27
K	9	Composite tooling prep	6	3			16	9	4	9	6	8	2		1		6			6.36	62	79
K	10	Cure cycle	12	8	3		16	9	12	9	16	16	2		2	2	15			9.38	35	45
K	11	Dissimilar Mat'ls & Galvanic Action	20	16	8	12	12	6	16	9	16	20	8		3	25	20	4	4	13.00	13	21
K	12	Engineering Drawing practices/stds	20	4	6	20	2	12	9	4	9	8	9	9	2	16	9	12	12	9.44	34	44
K	13	Extrusion Procurement Reqm'ts	6	9	2	1	6	6	4	4	20	12	3		1	2	15			6.50	60	77
K	14	Fasteners (permanent)	12	16	25		16	12	12	25	20	20	25	25	25	25	15			19.50	3	5
K	15	Fasteners (removable)	12	9	12	12	16	8	12	25	20	20	15	6	25	20	15	4	4	14.44	11	18
K	16	Finish Codes	25	20	25	12	16	6	8	25	20	16	16	12	25	9	12			16.47	5	9
K	17	Forging	12	6		9	6	6	9	9	20	12	3		1		12	9	9	8.77	42	54
K	18	Forming Practices	12	6	16		12	6	4	9	20	12	20	4	3	12	12			10.57	24	32
K	19	Heat treatments	16	25	8	6	20	8	12	9	20	16	12	4	6	12	20	4	4	12.38	15	23
K	20	Hydrogen Embrittlement	12	15		6	20	9	16	9	20	12	4		1		15			11.58	20	28
K	21	Laminate loading	4	5			16	8	9	9	20	16	3		1		9			9.09	36	47
K	22	Laminate Mat'ls	12	3			16	6	12	9	20	16	3		1		12			10.00	29	39
K	23	Laminate rework	25	4			16	6	12	9	20	16	4		1		20			12.09	18	26
K	24	Lubricant coats	4	9	6	6	6	6	4	9	20	12	3		4	2	9	4	4	6.93	56	72
K	25	Machine shop practices	9	12	8	16	9	6	16	9	20	12	8		1	4	16	9	9	10.33	27	36
K	26	Machining practices	12	12	8	9	9	4	6	9	20	12	9		1	6	9			9.00	37	48
K	27	Masking for etch	9	12	3	2	9	4	1	9	20	12	3		1	3	9			6.93	57	73
K	28	Mat'l Cutting	6	4	16	9	6	6	2	9	9	12	3		1	8	9			7.14	54	67
K	29	Mat'l Damage Removal	9	8	16	15	9	6	12	9	20	12	20	20	1	16	12	9	9	12.13	17	25
K	30	Mat'l Substitution	16	9	8	9	8	9	16	4	20	12	8	6	4	16	15	6	6	10.38	26	35
K	31	Metals behavior	25	25	2	6	20	9	16	16	20	12	6	6	3	16	10	4	4	12.25	16	24
K	32	Metals properties	9	25	4	9	12	9	6	16	20	12	15	3	3	12	8	4	4	10.44	25	34
K	33	NDI Processes	16	25	6	6	12	6	9	12	20	16	8	12	6	3	12			11.27	21	29
K	34	Part or assy fit/form/function	20	25	25	16	16	12	20	25	20	25	20	20	12	25	20	12	12	19.56	2	4
K	35	Peening	4	6		4	6	6	4	9	20	12	3		1		8	4	4	6.69	59	76

(Exhibit D.6 continued)

Knowledge (K), Skill (S), or Ability (A)	Index	Name	Supvr	GL1	GL2	GL3	Eng1	Eng2	Eng3	Eng4	Eng5	Eng6	Eng7	Eng8	Eng9	Eng10	Eng11	Eng12	Eng13	Importance (Average C*F)	C Rank Order (current)	C Rank Order (future)
K	36	Plastic Welding	1	1			2	4	6	1	20	3	3		1	9	6			4.75	71	88
K	37	Plating/electro-depositing	15	16		4	20	12	16	9	20	12	3		1		12	4	4	11.08	23	31
K	38	Primer	12	15	8		12	9	9	9	20	16	8	3	12	12	12			11.21	22	30
K	39	REX-grain	6	12			12	8	12	9	20	12	4		1		10			9.64	31	41
K	40	Sealers	6	9	6	4	6	6	4	4	20	16	12	6	6	6	6	4	4	7.56	50	62
K	41	Sheet mat'l procurement	8	4	3		4	12	4	4	20	2	3		1	2	9			5.85	65	82
K	42	Sheet mat'l quality	3	6	3		6	6	4	4	20	12	3		1	4	9			6.23	63	80
K	43	Shop practices	9	16	3	9	6	12	4	6	9	6	8	6	3	3	6			7.07	55	68
K	44	Staking Operations	4	9		6	6	4	6	9	20	12	4		1		6	9	9	7.38	53	66
K	45	Thermosetting	4				9	4	9	9	20	12	2		1		6			7.60	49	61
K	46	Topcoats (Finishes)	4	6	1	4	4	4	4	9	20	12	6		1	2	8			6.07	64	81
K	47	Transparency Inspection	9	9			6	4	9	9	20	8	3		1		4			7.45	52	65
K	48	Vendor Codes	2		3		2	4	4	9	6	6			1	4	9			4.55	72	90
K	49	Weld processes	16	20	2		16	6	9	9	20	12	4		1	2	9			9.69	30	40
K	50	Weld symbols	16	4	3		9	4	12	9	20	12	8	1	2	1	9			7.86	48	60
S	1	Determine damage cause	9	9	16	20	9	12	16	25	20	12	12	12	6	12	12	8	8	13.13	12	20
S	2	Determine weld joint type	12	6	3		6	4	12	9	9	12	8	2	1	1	20			7.50	51	63
S	3	Determining load path	16	12	20		12	9	16	25	20	20	16	12	12	25	15			16.43	6	10
S	4	Differentiate among mat'ls	2	9	3		6	6	6	25	9	12	20	3	2	1	8			8.00	47	59
S	5	General math	25	16	15	16	6	12	15	25	20	25	8	9	9	20	12	16	16	15.56	8	13
S	6	ID approximate surface	1	1	6	9	4	4	4	9	9	12	3		1	2	12			5.50	67	84
S	7	ID good v bad mat'l edge	1	9	6	9	9	4	9	9	9	12	3		1	2	12			6.79	58	74
S	8	ID REX-grain	9	12			12	6	16	9	9	12	4		1		15			9.55	33	43
S	9	ID visible mat'l defect	12	6	6	12	9	6	6	9	9	12	8		1	12	15	12	12	9.00	37	48
S	10	Interpret casting dwgs	9	3			8	6	12	9	20	10	5		1		15			8.91	41	53
S	11	Interpret eng dwg	25	25	20	16	20	9	20	25	20	25	20	16	20	25	12	16	16	19.63	1	3
S	12	Interpret forging dwgs	9	3			8	9	12	9	20	15	5		1		8			9.00	37	48
S	13	OPSS Reading	16	25	16	9	12	9	16	25	6	25	20	6	12	25	12	12	12	15.38	9	14
S	14	Read oven/autoclave	4	2	6		6	4	9	6	6	12	4		1	1	6			5.15	70	87
S	15	Reading PowerView	6	6			3	4	6	6	6	12			1		3			5.30	68	85
Future KSAs																						
A	101	Interpret test results	6	8							8						6			7.00		69
A	102	Locate appropriate info in reports	16	12							8						6			10.50		33
A	103	Use of analysis texts	4	4							2						8			4.50		91
K	101	Analysis Tools	15	8							25						12			15.00		15
K	102	Cold Expansion Process	4	12							4						8			7.00		69
K	103	Crack Initiation Characteristics	12	12							4						8			9.00		48
K	104	FAR Requirements	20	9							4						4			9.25		46
K	105	Fatigue critical locations by model	20	12							12						10			13.50		19
K	106	Fatigue basics	25	20							12						20			19.25		6
K	107	FEM Principles	3	4							3						9			4.75		88
K	108	Margin of safety	8	16							8						9			10.25		38
K	109	Mechanics of materials	25	25							16						20			21.50		2
K	110	MMPDS (Mil-Hdbk-5G)	20	12							6						20			14.50		17
K	111	Physics of aircraft	25	25							25						16			22.75		1
K	112	Stress basics	20	20							12						25			19.25		6
S	101	Basic stress analysis	25	12							8						20			16.25		11
S	102	Fatigue software	20	6							3						1			7.50		63
S	103	FEM	4	4							2						2			3.00		94
S	104	Kt Values	9	12							3						3			6.75		75
S	105	Stress software	16	6							3						3			7.00		69

EXHIBIT D.7. SURVEY RESULTS – RATERS ESTIMATION OF HOURS TRAINING REQUIRED

Knowledge (K), Skill (S), or Ability (A)	Index	Name	Supvr	GL1	GL2	GL3	Eng1	Eng2	Eng3	Eng4	Eng5	Eng6	Eng7	Eng8	Eng9	Eng10	Eng11	Eng12	Eng13	Average Trng	Rank Order
Current KSAs																					
A	1	Analyze effects on part configuration	2		15	30				140		50	1	2			40			35.00	9
A	2	Communicating with Buyers/Suppliers	1		5	1				2		10	1				2			3.14	62
A	3	Discern affects on fit/form/function	2		10	30				140		80	1	6			40			38.63	7
A	4	Ergonomic Lifting	1		1	1						0	1							0.80	95
A	5	Inspect Welds	1		5					2		10	1	1			2			3.14	62
A	6	Locate info in manuals/specs	3		5	4				2		2	1		3		20			5.00	49
A	7	Radius gage usage			1	1				1		0	1	1			1			0.86	94
A	8	Read Lab Test Results	2		1	2				1		2	1				2			1.57	86
A	9	Review SCDs	1		5	1				1		1					1			1.67	82
A	10	Use of precision measuring instruments	2		1	3				2		0	1	1	3		10			2.56	74
K	1	Anodize	1		5	1				1		2	1				5			2.29	75
K	2	Case Hardening				1				1		2	1		1		3			1.50	89
K	3	Castings	4							1		2	1		6		10			4.00	55
K	4	Chemfilm	4		10	5				3		2	1				3			4.00	55
K	5	Cleaning mat'ls	4		5	3				3		2	1		6		5			3.63	59
K	6	CMM	1		1	1				1			1		4		5			2.00	80
K	7	Cold Bonding	4		5	4				1		2	1		1		3			2.63	71
K	8	Composite laminates manufacturing	20							3		4	1				80			21.60	18
K	9	Composite tooling prep	2							3		0	1				2			1.60	83
K	10	Cure cycle	3		10					3		6	1				10			5.50	43
K	11	Dissimilar Mat'ls & Galvanic Action	5		5	10				3		2	1				20			6.57	38
K	12	Engineering Drawing practices/stds	20		10	20				2		80	3	2			40			22.13	17
K	13	Extrusion Procurement Reqm'ts	1		5	1				2		2	1				30			6.00	40
K	14	Fasteners (permanent)	20		10					140		8	5	12	40		20			31.88	10
K	15	Fasteners (removable)	20		10	20				120		8	2	4	30		20			26.00	15
K	16	Finish Codes	5		10	4				10		2	3	1	8		5			5.33	45
K	17	Forging	8			10				3		2	1				5			4.83	50
K	18	Forming Practices	10		10					3		2	3	2	8		5			5.38	44
K	19	Heat treatments	20		10	10				3		4	2	3			30			10.25	30
K	20	Hydrogen Embrittlement	5			5				3		2	1				5			3.50	60
K	21	Laminate loading	20							3		0	1				10			6.80	37
K	22	Laminate Mat'ls	10							3		2	1				40			11.20	28
K	23	Laminate rework	10							3		2	1				40			11.20	28
K	24	Lubricant coats	3		5	2				3		2	1				5			3.00	64
K	25	Machine shop practices	2		10	4				3		2	1				15			5.29	46
K	26	Machining practices	2		10	2				3		2	1		40		2			7.75	33
K	27	Masking for etch	1		5	1				1		1	1				1			1.57	86
K	28	Mat'l Cutting	2		5	10				1		1	1		40		1			7.63	34
K	29	Mat'l Damage Removal	3		5	3				1		1	1	5			2			2.63	71
K	30	Mat'l Substitution	10		5	10				3		3	1	3			10			5.63	42
K	31	Metals behavior	15		10	80				5		2	1	15			10			17.25	24
K	32	Metals properties	10		5	20				5		2	2	10			5			7.38	35
K	33	NDI Processes	20		10	10				1		1	2	1	6		2			5.89	41
K	34	Part or assy fit/form/function	10		40	60				50		80	2	6	8		5			29.00	12
K	35	Peening	1			1				1		2	1		4		1			1.57	86

(Exhibit D.7 continued)

Knowledge (K), Skill (S), or Ability (A)	Index	Name	Supvr	GL1	GL2	GL3	Eng1	Eng2	Eng3	Eng4	Eng5	Eng6	Eng7	Eng8	Eng9	Eng10	Eng11	Eng12	Eng13	Average Trng	Rank Order
K	36	Plastic Welding	0							1		1	1				5			1.60	83
K	37	Plating/electro-depositing	10			1				3		2	1		8		2			3.86	57
K	38	Primer	10		10					3		2	1	3	4		2			4.38	53
K	39	REX-grain	3							2		2	1				5			2.60	73
K	40	Sealers	4		10	1				2		2	1	2	4		1			3.00	64
K	41	Sheet mat'l procurement	2		10					1		1	1				10			4.17	54
K	42	Sheet mat'l quality	1		5					1		3	1				2			2.17	77
K	43	Shop practices	10		10	2				3		4	1	2	4		10			5.11	48
K	44	Staking Operations	1			3				1		2	1				1			1.50	89
K	45	Thermosetting	2							1		0	1				2			1.20	93
K	46	Topcoats (Finishes)	3		10	2				1		3	1				1			3.00	64
K	47	Transparency Inspection	4							1		2	1				1			1.80	81
K	48	Vendor Codes	1		10					1		2					1			3.00	64
K	49	Weld processes	10		10					1		4	1		8		2			5.14	47
K	50	Weld symbols	5		5					1		2	1	1	4		5			3.00	64
S	1	Determine damage cause	3		10	5				120		40	1	1	4		2			20.67	20
S	2	Determine weld joint type	3		5					100		2	1	1			3			16.43	25
S	3	Determining load path	5		20					120		40	3	6	8		10			26.50	14
S	4	Differentiate among mat'ls	2		10					120		4	1	1			2			20.00	23
S	5	General math	1		1	1				1		0	3	1			2			1.25	92
S	6	ID approximate surface	2		5	1				1		2	1		4		2			2.25	76
S	7	ID good v bad mat'l edge	1		5	1				1		2	1		4		2			2.13	79
S	8	ID REX-grain	1							1		2	1				3			1.60	83
S	9	ID visible mat'l defect	5		5	2				1		2	2				3			2.86	69
S	10	Interpret casting dwgs	3							1		2	2		40		5			8.83	31
S	11	Interpret eng dwg	3		10	4				140		20	5	4	40		15			26.78	13
S	12	Interpret forging dwgs	3							120		2	2		40		10			29.50	11
S	13	OPSS Reading	3		5	3				1		2	1	1	8		5			3.22	61
S	14	Read oven/autoclave	2		5					1		2	1				2			2.17	77
S	15	Reading PowerView	1							1		2					2			1.50	89
Future KSAs																					
A	101	Interpret test results	4	8													2			4.67	51
A	102	Locate appropriate info in reports	6	8													5			6.33	39
A	103	Use of analysis texts	2	16													3			7.00	36
K	101	Analysis Tools	40														2			21.00	19
K	102	Cold Expansion Process	3	4													1			2.67	70
K	103	Crack Initiation Characteristics	20	40													2			20.67	20
K	104	FAR Requirements	40	16													5			20.33	22
K	105	Fatigue critical locations by model	10	20													10			13.33	27
K	106	Fatigue basics	20	20													2			14.00	26
K	107	FEM Principles	100	8													20			42.67	6
K	108	Margin of safety	5	4													2			3.67	58
K	109	Mechanics of materials	80	60													1			47.00	3
K	110	MMPDS (Mil-Hdbk-5G)	10	2													2			4.67	51
K	111	Physics of aircraft	160	40													3			67.67	1
K	112	Stress basics	2	20													2			8.00	32
S	101	Basic stress analysis	40	80													10			43.33	5
S	102	Fatigue software	40	80													20			46.67	4
S	103	FEM	80	60													40			60.00	2
S	104	Kt Values	40	12													20			24.00	16
S	105	Stress software	20	80													10			36.67	8

EXHIBIT D.8. SUMMARY PRIORITIZED SKILLS PROFILE WITH ESTIMATED TRAINING HOURS

Knowledge (K), Skill (S), or Ability (A)	Index	Name	Importance (Average C*F)	Rank Order (current)	Rank Order (future)	Estimated Trng
K	111	Physics of aircraft	22.75		1	67.67
K	109	Mechanics of materials	21.50		2	47.00
S	11	Interpret eng dwg	19.63	1	3	26.78
K	34	Part or assy fit/form/function	19.56	2	4	29.00
K	14	Fasteners (permanent)	19.50	3	5	31.88
K	106	Fatigue basics	19.25		6	14.00
K	112	Stress basics	19.25		6	8.00
A	3	Discern affects on fit/form/function	18.75	4	8	38.63
K	16	Finish Codes	16.47	5	9	5.33
S	3	Determining load path	16.43	6	10	26.50
S	101	Basic stress analysis	16.25		11	43.33
A	6	Locate info in manuals/specs	16.20	7	12	5.00
S	5	General math	15.56	8	13	1.25
S	13	OPSS Reading	15.38	9	14	3.22
K	101	Analysis Tools	15.00		15	21.00
A	1	Analyze effects on part configuration	14.82	10	16	35.00
K	110	MMPDS (Mil-Hdbk-5G)	14.50		17	4.67
K	15	Fasteners (removable)	14.44	11	18	26.00
K	105	Fatigue critical locations by model	13.50		19	13.33
S	1	Determine damage cause	13.13	12	20	20.67
K	11	Dissimilar Mat'ls & Galvanic Action	13.00	13	21	6.57
A	10	Use of precision measuring instruments	12.94	14	22	2.56
K	19	Heat treatments	12.38	15	23	10.25
K	31	Metals behavior	12.25	16	24	17.25
K	29	Mat'l Damage Removal	12.13	17	25	2.63
K	23	Laminate rework	12.09	18	26	11.20
K	8	Composite laminates manufacturing	12.00	19	27	21.60
K	20	Hydrogen Embrittlement	11.58	20	28	3.50
K	33	NDI Processes	11.27	21	29	5.89
K	38	Primer	11.21	22	30	4.38
K	37	Plating/electro-depositing	11.08	23	31	3.86
K	18	Forming Practices	10.57	24	32	5.38
A	102	Locate appropriate info in reports	10.50		33	6.33
K	32	Metals properties	10.44	25	34	7.38
K	30	Mat'l Substitution	10.38	26	35	5.63
K	25	Machine shop practices	10.33	27	36	5.29
K	4	Chemfilm	10.29	28	37	4.00
K	108	Margin of safety	10.25		38	3.67
K	22	Laminate Mat'ls	10.00	29	39	11.20
K	49	Weld processes	9.69	30	40	5.14
K	39	REX-grain	9.64	31	41	2.60
K	5	Cleaning mat'ls	9.60	32	42	3.63
S	8	ID REX-grain	9.55	33	43	1.60
K	12	Engineering Drawing practices/stds	9.44	34	44	22.13
K	10	Cure cycle	9.38	35	45	5.50
K	104	FAR Requirements	9.25		46	20.33
K	21	Laminate loading	9.09	36	47	6.80

(Exhibit D.8 continued)

Knowledge (K), Skill (S), or Ability (A)	Index	Name	Importance (Average C*F)	Rank Order (current)	Rank Order (future)	Estimated Trng
K	26	Machining practices	9.00	37	48	7.75
S	9	ID visible mat'l defect	9.00	37	48	2.86
S	12	Interpret forging dwgs	9.00	37	48	29.50
K	103	Crack Initiation Characteristics	9.00		48	20.67
K	1	Anodize	8.93	40	52	2.29
S	10	Interpret casting dwgs	8.91	41	53	8.83
K	17	Forging	8.77	42	54	4.83
A	8	Read Lab Test Results	8.33	43	55	1.57
K	3	Castings	8.18	44	56	4.00
A	5	Inspect Welds	8.07	45	57	3.14
K	7	Cold Bonding	8.07	46	58	2.63
S	4	Differentiate among mat'ls	8.00	47	59	20.00
K	50	Weld symbols	7.86	48	60	3.00
K	45	Thermosetting	7.60	49	61	1.20
K	40	Sealers	7.56	50	62	3.00
S	2	Determine weld joint type	7.50	51	63	16.43
S	102	Fatigue software	7.50		63	46.67
K	47	Transparency Inspection	7.45	52	65	1.80
K	44	Staking Operations	7.38	53	66	1.50
K	28	Mat'l Cutting	7.14	54	67	7.63
K	43	Shop practices	7.07	55	68	5.11
S	105	Stress software	7.00		69	36.67
A	101	Interpret test results	7.00		69	4.67
K	102	Cold Expansion Process	7.00		69	2.67
K	24	Lubricant coats	6.93	56	72	3.00
K	27	Masking for etch	6.93	57	73	1.57
S	7	ID good v bad mat'l edge	6.79	58	74	2.13
S	104	Kt Values	6.75		75	24.00
K	35	Peening	6.69	59	76	1.57
K	13	Extrusion Procurement Reqm'ts	6.50	60	77	6.00
K	2	Case Hardening	6.46	61	78	1.50
K	9	Composite tooling prep	6.36	62	79	1.60
K	42	Sheet mat'l quality	6.23	63	80	2.17
K	46	Topcoats (Finishes)	6.07	64	81	3.00
K	41	Sheet mat'l procurement Reqm'ts	5.85	65	82	4.17
A	9	Review SCDs	5.71	66	83	1.67
S	6	ID approximate surface roughness	5.50	67	84	2.25
S	15	Reading PowerView output	5.30	68	85	1.50
A	2	Communicating with Buyers/Suppliers	5.23	69	86	3.14
S	14	Read oven/autoclave data	5.15	70	87	2.17
K	36	Plastic Welding	4.75	71	88	1.60
K	107	FEM Principles	4.75		88	42.67
K	48	Vendor Codes	4.55	72	90	3.00
A	103	Use of analysis texts	4.50		91	7.00
K	6	CMM	3.69	73	92	2.00
A	4	Ergonomic Lifting	3.69	74	93	0.80
S	103	FEM	3.00		94	60.00
A	7	Radius gage usage	2.33	75	95	0.86